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## Marine technical training in Kenya

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WORLD MARITIME UNIVERSITY MALMO - SWEDEN

# MARINE TECHNICAL TRAINING IN KENYA

By

**Perminus Mungai Wainaina**

Kenya

A paper submitted to the faculty of World Maritime University in partial satisfaction of the requirements for the award of a

## MASTER OF SCIENCE DEGREE IN MARITIME EDUCATION AND TRAINING (ENGINEERING)

The contents of this paper reflect my personal views and are not necessarily endorsed by the UNIVERSITY.

Signature

A handwritten signature in dark ink, appearing to read 'Perminus Mungai Wainaina', written over a horizontal line.

Date:

4<sup>th</sup> October 1989.

Supervised and assessed by

C.E. Mathieu

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Professor - WORLD MARITIME UNIVERSITY

Co-assessed by

J. Makau

Chief Marine Engineer, Kenya Ports Authority

This Paper is dedicated to my dear mother

**MRS. JANE GATHONI WAINAINA**  
(1920 to 1989)

who passed away during my course of study at WMU.

She had shown a lot of interest in my studies throughout.

She encouraged me to complete this course even when she was sick and bedridden.

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## ABSTRACT

A recurring, yet reasonable question, posed by many of my colleagues is why the training of marine engineers in Kenya takes so long. They are also specifically interested in how marine engineering relates to other more familiar disciplines such as mechanical and electrical engineering.

This paper, in a narrative form, portrays different programmes followed in training marine engineers not only in Kenya but in various other countries. The inter-relationship between marine engineering and the other two engineering disciplines mentioned, has been illustrated by integrating all three within a single realistic training programme. The paper also touches on the education and training of other marine technical staff, without whom marine engineering would be incomplete.

In considering the national requirements for modernizing the marine engineering education and training, minimum global standards as expressed by the International Convention STCW (Standards of Training and Watchkeeping) are reviewed. Suggestions and recommendations are given with a clear understanding of Kenya's financial limitations, and therefore pinpoint only the easy way out of each problem situation. Some of my suggestions only seek clarification of the marine engineering position within the national education infrastructure.

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## CHAPTER 1

### 1.1

#### BRIEF HISTORY

Kenyan marine technical training must have started a long time ago although it was mainly on the hull section. Before the partition of Africa and the consequent colonization, Kenyans were making their own floating vessels. These were mainly dugout canoes which are still very common in and around Mombasa, along the Indian Ocean coastline, and on many lakes particularly on Lake Victoria. Farther north, on the Indian Ocean coastline, a more advanced form of a ship was and still is being constructed. This is the dhow which was introduced by the Southern Yemen Arabs at a point called Kizingitini, near the ancient port of Lamu, around the 11th Century.

The form of training which was going on in this industry was an on-the-job training of the son by the father. The father who, having proved himself by successfully making himself a fishing canoe, soon received orders from the community around him. Automatically he sought assistance from his son or sons who ended up being his apprentices. Having started the training earlier in life the interested son gained more experience than the father. He became a better canoe-maker and a specialist in the field.

When the British arrived in the late 19th Century, and decided to build a railway line between the Port of Mombasa and the shores of Lake Victoria, then another phase of technical training started. Initially they hired the dugout canoes and dhows to offload their light cargoes and gear from their much bigger steam ships. Later they were forced to build pontoons to offload the heavier gear

which they required for the building of the railway line. It was necessary then to build a workshop at Mombasa which catered to both marine and mechanical works to facilitate the building of the Kenya Uganda Railway line.

Initially there was no direct technical training in these workshops. The British Engineers in charge brought their fellow British to serve as foremen. From India they brought skilled and semi-skilled artisans and the black Kenyans were employed to work as labourers. With the expansion of the trade between East Africa and Europe in the early 20th Century, the demand for technical services both marine and mechanical increased dramatically. Upgrading of the experienced labourers became a necessity. Eventually an effort towards some form of organized on-the-job training was encouraged by the foremen, who had to find a way of coping with their increased workload. Most of the people who went through this form of training had no formal classroom education. However, a few of them who were very keen learnt to read and write from the British foremen and could finally read and interpret some simple engineering drawings.

By the mid 20th Century, the then East African Railways had established maintenance workshops at Mombasa, Nairobi and Kisumu in Kenya. Other similar workshops had been established in other parts of East Africa. But the largest of them all was and still is the Chief Mechanical Engineer's workshops complex in Nairobi. This became the greatest facility for maintenance of every aspect of steam locomotives, boggies, wagons and permanent way (railway line).

The facilities at the Chief Mechanical Engineer's workshops are very good for training on-the-job. There is

a large machine shop with many different sizes and types of machine tools; lathes, shapers, millers, drills and capstan lathe machines. Next to the machine shop, there is a tool shop in which cutting tools, jigs and fixtures are made. There are also the boiler and diesel repair workshop and the blacksmiths shop which has both coal and fuel oil fired ovens as well as steam and pneumatic powered hammers and presses. There is also a foundry with two pattern shops and a bessemer converter. Then there is the wheel shop where the locomotive wheels are re-tyred, a carpentry workshop, a millwright and the electrical workshop. There are many more technical facilities such as the drawing offices to be found within this large establishment, which all go well with the on-the-job training of both marine and mechanical engineering personnel.

However, around 1950, the East African Railways Corporation found it necessary to train their technical as well as non-technical personnel formally. They established the Railway Training School, popularly known as (RTS), at Nairobi South B. This became a modern institution which accommodated one thousand students and about 200 members of teaching and catering staff. Technical students were in the majority and undertook formal technical training in various trades such as fitting and turning, blacksmithing, electrical wiring, diesel electric fitting, wood working, maintaining of permanent way, marine fitting and building. Among the common subjects taught in the academic classes were mathematics, technical drawing, physics, mechanical engineering science, electrical engineering science and English language. Artisans trained in the Railway Training School started taking positions of importance in

the workshops in the late 1950's and early 1960's. After a short while some had even achieved the City & Guilds Diplomas in Mechanical or Electrical Engineering. These were promoted to foremen positions in various mechanical and marine workshops. Interesting is the fact that most graduates of the Railway Training School did not remain to work for the then East African Railways & Harbours but joined the government service, other parastatals and privately owned industrial companies.

At Independence time in 1963, there was concern to ensure that Kenya had enough trained Africans in every sector of its economy. The East African Railways and Harbours was forced to recruit and train marine officers. Since there were no adequate facilities and teaching staff for this level of training, the cadets had to be sent to the United Kingdom. In the first group, there were two marine engineering students who started their training around September 1964 at the South Shields Marine and Technical College, in the United Kingdom. They were required to have 1st. or 2nd. Division passes in the Cambridge Overseas School Certificate O-levels. This was an Examination which was set and marked in the United Kingdom and was intended for the students of the former colonies of the United Kingdom who had completed 12 years of education. It was a requirement for the cadets to have passed at credit level in mathematics, physics or physics with chemistry, and the English language, besides having at least six subjects at credit or distinction passes in order to be in the 1st. or 2nd. division. The recruitment age was also restricted to between 19 and 22 years.

## CHAPTER I I

### LOCAL TRAINING FOR ARTISANS

#### 2.1 The Kenya Ports Authority

A good proportion of the senior artisans and foremen undertook their training in the Railway Training School as described in Chapter I. Others were trained on the job from labourers and after passing set craft examinations they were promoted to the artisan levels.

At the present moment, the Kenya Ports Authority is a separate parastatal from the Kenya Railways. It therefore no longer trains its artisans at the Railway Training School as was the case before the two parastatals were separated in the 1960's.

The artisans of the Kenya Ports Authority consist of four major groups. The marine technical staff whose operations are centred at the KPA's Mombasa Dockyard, the mechanical, the electrical and the civil engineering all operating from workshops located at Kipevu in the Port of Mombasa. It is, however, the training of the first group which this paper will be discussing.

Recruited into the Kenya Ports Authority generally after 12 years of school education, the artisans are required to have at least a third Division of KCE (Kenya Certificate of Education). This is the Certificate which replaced the

Cambridge Overseas School Certificate, O-levels as mentioned in Chapter I. It is required that the candidates who are to join the marine technical staff should have at least a pass in mathematics, physics, or physics with chemistry or any other science subject. It is also a requirement for them to pass a swimming test and a medical fitness examination. Once they enter into the marine technical department, these boys aged between 17 and 19 years are subdivided into various workshops in the Dockyard where for the first three months they are observed to determine their respective aptitudes. After this they are moved around until one settles down on one of the eight main trades under marine department. These are: diesel fitter, machinist, electrician, radio technician, carpenter, plater, welder and plumber.

The above eight groups are trained both on-the-job as well as at Bandari College which is a Kenya Ports Authority's training facility for both technical and non-technical staff. In the Bandari College, the recruits are taught elementary engineering drawing, mathematics, physics, mechanical engineering science, and the rudiments of their various trades. These courses take from six months to two years depending upon the trade. Progressive assessments are carried out by the instructors in their respective subjects and the reports are forwarded to the training section of the Kenya Ports Authority. From these reports the excelling trainees, in most cases one or two, are selected and sponsored by the Kenya Ports Authority to pursue diploma courses either at the Kenya Polytechnic Nairobi or at the Mombasa Polytechnic. These people are guaranteed an assistant foreman's job after successful completion of their diploma or higher diploma courses in either mechanical, electrical or electronic engineering.

The bulk of the marine trainees are then categorized into two groups: the marine afloat and the marine dockyard. The first group joins the operation group who are engaged in the running of the marine engines in all marine floating craft. These marine floating craft engines range from 20 BHP capacity in the work boats, to over 1500 BHP engine capacity in the salvage tug. The second group joins the marine workshop staff who act as a support for the operations. The workshop staff is engaged in both planned and breakdown maintenance of all marine craft. It carries out maintenance on both hull and engine works.

Once a group of recruits joins the marine afloat, they are taken in as greasers and learn the operation of the engines on the job for a year. At the end of this period, those who feel ready for an examination may apply to sit for a junior engine room assistant examination. If they pass the above examination, they are promoted to the position of the junior engine room assistant where they serve for two years. Then they are allowed to appear for the next examination which qualifies them to serve as engine room assistants. After another two years of service the successful engine room assistants may apply to sit for their final examination which is called the third class (foreign going) examination. This certificate allows them to serve in the capacity of senior engine room assistants.

Meanwhile the group which joined the workshops trains on the job for one year after which they sit for grade III trade test in their respective fields. Those who qualify are promoted to assistant artisans. They serve for another two years in this capacity and then may apply and sit for the grade II trade test which will prove their

capability of handling the duties of a skilled artisan. After two more years of service, the successful artisans may be allowed to sit their final examination which is called the grade I trade test. This allows them to serve in the capacity of assistant foremen, more commonly referred to as charge hands.

## 2.2 The Kenya Railways

Since the Kenya Railways and the Kenya Ports Authority used to be run as one organization before 1970, the older generation of artisans had followed the same kind of training as their counterparts in the Kenya Ports Authority. The numbers of the recruits in the Kenya Railways marine department has, however, gone down drastically since the separation of the two parastatals and the break of the East African Community in the 1970's.

With the separation of the two bodies, the Kenya Railways was left to control the shipping on Lake Victoria. This was all right for a time before the break of the East African Community in the mid 1970's. By then Kisumu was the main repair and assembly workshop for all the vessels registered in all the ports on this Lake such as Jinja and Portbell in Uganda, Mwanza, Musoma and Bukoba in Tanzania. When the East African Community died, Ugandan and Tanzanian vessels stopped using the Kisumu facility. This reduced the workload and consequently the number of recruits went down to a very low figure.

There is only one vessel whose twin engines have a capacity of 1480 B.H.P each. This is a wagon ferry, Mv. Uhuru, whose LOA is 301 ft., Moulded Breadth 54 ft. and displacement is 2800 tonnes at 14 ft. draft. The



Registered Gross Tonnage is 1200 tonnes. The rest of the fleet consists of four passenger vessels whose lengths lie between 84.1 ft. and 107.6 ft., a small lighter towing tug, two small cargo boats, a mooring boat and some dump lighters. It is no wonder then to note that at the present moment the Kenya Railways Corporation recruits only a few trainees to replace the retiring artisans only. When the author visited Kisumu marine workshops in January 1989, he found only four trainees under the following training programme:

The recruits who have had 12 years of academic education are supposed to have credit passes at O-level's, now referred to as KCE in mathematics, English, and any other science subject. The period of their internship is four years of which 20% is classwork, 30% practical workshop training which is mainly fitting, and 50% on-the job training on board ships. Upon the completion of the four year period they are allowed to appear for the engine room assistant examination, formerly known as the harbour tug examination. They are then promoted to the positions of junior engineers in the lake vessels. After two more years of service, the junior engineers or the engine room assistants as they are generally called, may appear for the third class foreign going certificate. Once they achieve this qualification they are allowed to serve in the engine rooms of the lake vessels up to the capacity of the second engineer. Hence the third class foreign going certificate is supposed to be the climax of the local marine engineering training both in the Kenya Railways Corporation and the Kenya Ports Authority.

### 2.3 African Marine & General Engineering Co. Ltd.

This company is a commercial ship repair yard with the largest drydock in the whole of the Eastern African Coast, other than South Africa. The drydock can handle ships up to 50,000 tonnes. The company undertakes all types of ship repair. In addition to hull cleaning, sand-blasting, cathodic protection, propeller shaft withdrawal and propeller blade renewals, stern tube seals examination and assemblies, the company undertakes main engine and auxiliary engine overhauls, pump repairs, boiler tube renewals and cleaning, plumbing works, tank cleaning, painting and cement washing as well as hydraulic testing for tanks. The company also undertakes crankshaft grinding of medium and high speed engines as well as remetalting of thick-shell bearings. On the part of superstructure, they handle all carpentry work and cabin insulation. Electrical alternators, motors, switchboard and distribution problems are also tackled. The company subcontracts other jobs such as refrigeration and air-conditioning, while they themselves service the life-rafts. Another important service is that of metal casting. They have a small foundry from which cast iron parts, bronze and aluminium components of simple geometric forms are cast. The pattern making is done in their carpentry workshop. It goes without saying therefore that in order to offer and maintain quality service to the ships in all the different fields mentioned above, the company must have a comprehensive scheme of training for marine artisans in particular, and in other closely related areas.

The trainees for this company are generally recruited from technical high schools after an academic education of 12 years. During the four years in the technical high school, the education is highly biased with technical subjects. To pass the AMGEC's (African Marine and General Engineering Co.'s) interview for artisan trainees, students are required to have passed KCE (O-levels) in subjects such as mathematics, engineering drawing, and any other science subject. This enables them to enter an apprenticeship period of four years. The other source of the company's artisan trainees is the Kenya National Youth Service. The youths must have had at least 10 years of academic education before being recruited into the National Youth Service. At the National Youth Service they undergo technical training in various trades for two years, and sit for Government trade test grade III in their respective specialisation. By the time of their recruitment into the training scheme of the AMGEC, they are expected to have passed at least the grade III Government trade test in either motor mechanics, electrical diesel fitting, electrical wiring, fitting and turning, welding, wood working or blacksmithing.

It takes only a short time for these trainees to be allocated to various workshops noting that selection of their respective trades had already been accomplished either at the high school level or at the National Youth Service. It is also easier for the Company to estimate the exact number of artisan trainees they will recruit into each trade considering the demand of the services from ships which are their main clients.

Once recruited, the artisan trainees spend the first year

on on-the-job training. They work as assistants to the qualified artisans acting as spanner boys, cleaners or observers. Depending on one's own initiative, responsible tasks can be tackled by the trainee, but only under the guidance and supervision of the qualified artisan. Most of the work at the AMGECo is usually carried out on the ships, which are either in the dry dock, alongside their wharf or afloat in the Kilindini's anchorage points at Mtongwe or Portreitz. The only exception is for the machinists whose bulk of work lies in the machine shop. But they too occasionally visit some ships to take crankshaft deflections. Due to the nature of their jobs, these trainees become properly ship-oriented by the end of their first year, and hence have an idea as to what they will need to know in the next three years of training.

The 2nd year is spent with 50% of the time in the classroom at the AMGECo and the rest in the workshops. While in class they update themselves with mathematics, physics, English, engineering drawing, and simple mechanical and electrical principles. They are taught to recognise and properly use and care for various common engineering tools. In the workshop practice, they are given assignments to make some hand-tools, jigs, jacks, pullers and stands for various uses. They are encouraged to be inventive. At the end of the 2nd year, their assessments are made by the training officer. Those who excel, one or two and a maximum of four, depending on the availability of training funds, are sponsored for higher technical courses at the Mombasa Polytechnic. The rest are booked for either the grade II or III Government trade test. They continue training on-the-job until they pass the Government trade test grade I, when they are considered to have completed their training and are thus designated as

artisans grade one. With the above trade test Certificate, the artisans may progress with experience and aptitude to the post of assistant foreman. However, these posts generally go to those trainees who excelled in the 2nd year and obtained sponsorship to the Mombasa Polytechnic where they usually graduated with either the Ordinary or Higher Diploma in mechanical, electrical, or electronic engineering.

In the past decade, when the Eastern Africa National Shipping Line Co. Ltd, owned by the four Eastern African States ; Kenya, Uganda, Tanzania and Zambia was operative, many artisans from AMGECo were recruited to serve as junior engineers in the ships. This was done on the strength of the Government trade test grade I certificate. Although they did well in ships as junior engineers, none of them fared well with the D.T.I. (Department of Trade and Industry) of the United Kingdom, examinations for marine engineers. They all failed to pass the Part A of the second engineer's motor certificate. Mostly, they had difficulties in mathematics, marine engineering drawing and thermodynamics.

#### **2.4 The Southern Engineering Company Ltd.**

This Company is the second largest commercial ship repair firm in Kenya after the African Marine and General Engineering Company discussed above. It was formerly a sister company to the Southern Line Co. Ltd. which owned four to six coasting ships during the 1960s and up to the late 1970s. In the 1980s the two companies were separated and sold to different people. The new owners of Southern Engineering Company Ltd. retained the name and continued offering repair services to small coasting ships and

boats. They also continued to build small crafts on order, and bought and operated some fishing trawlers as well. While the Southern Line Company went under another name in the Register, they continued owning sea-going vessels and in particular salvage tugs.

The two companies above at the present seem to be operating with a lot of uncertainties. Their training schemes at the present are undefined, but I think it is worthwhile to mention something about the training program in the 1960s and the 1970s. This will help us to understand the potential the country is having at the moment, in terms of marine technical manpower, trained in this company during that period, as well as its viability as a future training facility for marine technical staff.

The Southern Engineering Co. Ltd. mainly consists of a small workshop facility. The workshop has a shaded floor with a few machines like lathes, drills, grinders and work benches. Any complicated machining or grinding was generally subcontracted to the AMGECO which is just across the creek. Beside the workshop was the main store for both materials and the spares for the Southern Line ships. Above the stores were the Administration offices. Outside this building lay the plate-yard to the right where Lloyd tested M.S. plates for ship repair were stored on racks. To the left lay the boat-building yard with improvised slipways. And right in front of the building was the landing pontoon which separated the shallows near the quay and the deeper waters where the coasters moored when under repair. This facility did not have a dry dock or a slipping facility for vessels. The best it could do is to beach the smaller crafts near their open air boat-building yard and work on the hulls only during the low tides.

Otherwise for this kind of repair they had to book for a place at the AMGEC0.

Having regard to the aforesaid it is obvious that the activities of SECo. slightly differed from those of the KPA, the KRC and also the AMGEC0. Their major role was to offer technical support to the operating Southern Line ships. This they did by supplying extra skilled hands during machinery overhauls on board ships, doing plumbing and tank-cleaning and all the preparatory works prior to dry-docking. The workshop served as the initial training ground for the marine fitters who later joined the coasters as junior engine room assistants. It also served as the main technical store for the ships spare parts and consumable materials required during the voyages.

The training program for the lucky few recruits consisted of four years apprenticeship period. Joining after twelve years of academic education and having graduated from either a technical or grammar school, one was expected to have at least a third Division at O-levels with credit passes in at least mathematics, English and any other science subject. Then the trainee would spend one year on-the-job training at the workshops. During this time he would be assigned to work under a qualified artisan during the busy periods, or be given various craft practice exercises by the training officer when there wasn't enough work in the workshop. Normally these exercises would involve filing, machining, welding etc.

Depending on the business situation the recruit would continue his training on-the-job ashore or join one of the ship's crew during his second year. Ashore, he would continue working under the guidance of a qualified

artisan. If at sea, he would work alongside the greaser from whom he learned to clean the engine room machinery, the overhauled parts, the tools and spares. He was taught how to grind valves, to pump out the bilges and clean the purifiers and oily water separators. He also learned to paint the engine room machinery and spaces, and learned the general picture of the essential engine systems i.e. the cooling (fresh and sea water), lubrication and fuel oil systems. He would also learn the operation of the air compressors, depending on whether it was a simple or complicated system whereby a greaser could be allowed to handle alone.

At the end of the second year, which happened to be his first year at sea, the recruit could apply and sit for the junior engine room assistant examination if he felt ready for it. Upon passing he would continue at sea and be allocated duties of the junior engine room assistant for a period of two years. During this period, he would be encouraged by the 2nd and chief engineer to study at sea. He would also be encouraged to trace and sketch line diagrams of all engine room systems; cooling water (fresh and salt), lubricating and fuel oil, the starting air, the bilge and fire, the bunkering and ballasting, refrigeration and air-conditioning. He was also encouraged to read main engine and auxiliary machinery manuals and to recognise the various machinery spare parts stored in the engine room store with the aim of getting a quick access to them whenever required during the overhauls. Access and use of ordinary and special engineering tools was gradually imparted to the learning engineer if he showed keen interest to co-operate with the 2nd engineer in particular. He was also taught to take various readings of running machinery and to record the



data under the relevant engine room log book columns. Depending on how sharp his brain was and on how much effort and determination he applied, the learning engineer would have learned, in general, the purpose of each major machinery or machinery part in the engine room by the end of two years service as a junior engine room assistant. He was therefore allowed to apply and sit for his engine room assistant examination after having a total of three years sea experience. On passing the examination the learner engineer would be promoted to the position of the engine room assistant and work directly under a watch-keeping engineer. This was a responsible position. The person holding this certificate was supposed to be able to operate each and every piece of machinery in the engine room and also some outside the engine room. He was supposed to be able to detect the malfunctioning of any piece of machinery or part thereof and take remedial action or draw the attention of the watch engineer to such a malfunction. Generally he made the necessary adjustments to the valves in the cooling systems to ensure that the machinery was operating at the optimum temperature. He supervised the junior engine room assistant and the greaser and taught them anything they needed to know that he knew. If this man was doing his duties diligently he would be ready to sit for his final certificate - the third engineer's foreign going certificate at the end of his 4th year at sea. With the above certificate the man could be allowed to sail in the position of a watchkeeping engineer either as 4th, 3rd, or 2nd on the coasting vessels whose engine capacities do not exceed 750kW, or as a junior engineer in the foreign going vessels of unlimited propulsion engine capacities.

After serving for 18 months in this position he could

apply to the British marine colleges who would assist him to prepare for the 2nd engineer's part A & B Examination of the D.T.I., of the United Kingdom. If he succeeded in the above exams he would be required to practise at sea for a further period of 18 to 24 months in the capacity of a watch-keeping engineer in a foreign going ship of 3000 kW and above engine capacity, after which he could again join a British marine college and prepare himself to sit for chief engineer's parts A and B examination by the D.T.I., of the United Kingdom.

## **2.5 Other Marine-Related Firms**

Besides the above mentioned four firms with proper marine organization, there are other firms which are small and have no definite training programmes for their marine technical staff. Some of them, however, try to attract the already trained staff from the KRC (Kenya Railways Corporation), KPA (Kenya Ports Authority), the Kenya Navy or any of the other firms dealt with above.

Some of these small firms consist of; the Kenya Fisheries Research Department which has three fishing craft based at Kisumu, and one based at Mombasa, the police patrol boats on the Lake Victoria and Mombasa, and a large number of smaller craft which are privately owned, existing on the lake as well as in the ports of Mombasa, Malindi and Lamu.

Whilst the majority of the smaller craft in Kilifi are generally engaged in the fishing industry, those in Lamu and Kisumu engage in either liner or tramping business. They carry passengers and cargo between the mainland and the islands. For instance, the Port of Lamu is situated on an island and the road communication on the mainland

terminates at a point known as Mkowe. Thus all food supplies from the agricultural rich hinterland (particularly the Lake Kenyatta Settlement Scheme), and the commercial merchandise from Mombasa, have to be ferried across a stretch of about six miles between Mkowe and Lamu Island. Passengers too, consisting of farmers, tourists, traders, Government servants and administrators commute daily to and from the island. The island acts as the main commercial centre and the mainland as the main food and fuel supplier. The island also serves as the main distribution point for both raw and manufactured goods for the whole of the Lamu District. It is of prime importance to maintain the sea transport between the island and the mainland in a safe and efficient manner.

According to the Kenya Ports Authority shipping office at Lamu, the following figures for registered boats were available:

<u>Type of Craft</u>	<u>Year of Licensing</u>		
	1986	1987	1988
Cargo	140	132	88
Passenger	80	76	81
Fishing	151	182	137

The above figures only represent a small number of vessels which voluntarily came to the shipping office for registration and licensing. It is estimated however that there are more than twice this number of unlicensed vessels in Lamu alone, due to the fact that the system of licensing only started in 1986, and the drive has not been very forceful.

The important point to note however, is that although there is this large number of vessels in operation, there

has been no formal training or a training facility for the operators. Most of them have learned it from the family or are self taught, particularly in the fishing industry.

According to the shipping office in Lamu, about twenty operators had turned up in his office for certification since 1986. They were directed to the main shipping office at Mombasa where examinations were conducted and certificates of competency issued to those who passed.

It is also important to note here that there is need to establish a training facility for small craft operators of the private as well as the Government owned vessels. This may be suitably established at Mombasa or Kisumu where the facility and accommodation for staff and students can be easily acquired.

## CHAPTER I I I

### EDUCATION & TRAINING OF FOREIGN GOING MARINE ENGINEERS FOR KENYA

The system for training marine engineers for F.G. (Foreign Going) certificates is basically of the United Kingdom design. The term 'Foreign Going' means that the ships the officer is qualified to operate can be involved in deep sea voyages, otherwise referred to as international trade. There are two main systems which have been followed by the presently qualified marine engineers in Kenya today.

#### 3. F.G. Marine Engineers' Training In The United Kingdom

##### 3.1.1 Phase I

The first group of cadets were recruited directly into the British cadet training system in 1962. This group however did not fare very well. Another group started in 1964. The recruitment standards had been raised. Before sitting the entrance examination, which consisted of mathematics and English as written papers, and oral as well as medical examinations, they had to have undergone 12 or 14 years of general education and passed O-levels in 1st or 2nd Division, which meant distinctions and credits in at least six subjects in which mathematics, physics, chemistry, and English were mandatory. Alternatively the candidate had to have one principal pass in mathematics or any other science subject and two subsidiary passes in others at A - level.

After recruitment the cadets were sent to British marine colleges such as the South Shields Marine and Technical College or the Glasgow College of Nautical Studies. Here

### 3.1.2 Phase II

The college training period of the first two years is generally referred to as Phase I of training. The consequent training at sea for a period of 12 months is referred to as Phase II. The cadet entering this phase of training was expected to be a holder of the ordinary diploma in marine engineering. It was mandatory that at least 10 of the 12 months at sea be spent on foreign going commercial ships with propulsive engine power of 3000 kW. or more. The training phase was also characterized by the cadet record book in which various tasks of definite significance to a marine engineer were listed down and had to be counter-signed by the chief engineer when he was satisfied that the cadet had performed the tasks satisfactorily. Of similar importance during this phase of training was the correspondence course which was posted to the cadet from his previous college. The course covered engineering knowledge, electrotechnology, and naval architecture. In the power plant, the course dealt with steam boilers, steam engines and steam turbines, feed pumps, condensers, diesel engine for propulsion and auxiliary purposes, bilge and fire pumps, heat exchangers and refrigeration.

The electrotechnology covered insulation resistance testing for motors and generators and power distribution, synchronizing and load sharing, load shedding and stoppage of generators. Emphasis was laid on the identification and the proper use of electrical measuring and testing instruments such as the megger and avometer. Maintenance of the batteries for radio and emergency lighting was also emphasized. Electronics was addressed at the introductory

stage.

In naval architecture, they covered hydrostatics, stability, resistance and speed, free surface effect due to liquids in tanks, ships' structural strength, and ships' design for the stern and bows with reference to maneuverability and wave-making respectively. The deck machinery such as the windlass, the capstan, the derricks, chain stowage locker and the anchor were studied and their positioning was related to their function.

The correspondence courses were sent out to the cadets in units. Questions were written at the end of each study unit. The cadet had to try to answer the questions on his own. Where extreme difficulties were experienced, however, the third, second or chief engineer would try to help him understand the course material rather than give him a direct answer. The final answers to the correspondence material were discussed by the second and chief engineers before being passed to the captain for posting to the college. The corrected papers and the next course unit were posted together through the ship's captain and then the chief engineer to the cadet. Again the second or the chief engineer would discuss the assessments with the cadet, and help him plan the course of study for the next unit.

### 3.1.3 Phase III

Having completed the mandatory 12 months in the foreign going ship of the engine capacity 3000 kW or above, the cadets rejoined suitable marine workshops, preferably with dry docks, where they worked for a period of six months. The next six months were spent in marine academies where

they polished most of the theory studied while at sea through the correspondence courses. Alternatively the 12 months could be spent simultaneously for practical and theoretical training in a college which was suitably equipped for marine engineering workshop training. Another third alternative existed where a sandwich course could be organized. This required two days a week in the class for theory and three days at the marine or heavy duty mechanical workshops for practical training. Greater priority was given to the practical training in either case.

During the workshop training at the dry-dock the cadet was exposed to the following :

- a. Preparation of the dry-dock prior to the docking of a ship.
- b. The docking procedure itself.
- c. Examination of the dry-dock list and the job subdivision to various workshops.
- d. The execution of the most important jobs in the list such as the opening of main engine units, overhaul of generators, boilers or turbines.
- e. The lowering of the anchor chain on the dry-dock and the inspection thereof as well as the inspection of the chain locker.
- f. The gas-freeing of tanks and other enclosed spaces, and preparing them for entry, either for repair or inspection purposes.
- g. The working of various sections of the workshop in order to be familiar with different methods of manufacture and repair, of the many different machinery components, and the various types of heat treatments generally applied.
- h. The making of a clear sketch of the ship's hull



and a detailed placement of all the underwater appendages such as the propeller, the rudder, the stabilizers, bilge keels, sacrificial anodes, echo-sounder's pick up point, the low and high sea-suction boxes and grids.

- i. Using of the 'lines plan' drawing, where the workshop is involved in ship-building, particularly during the laying out of the ship's hull for construction.
- j. Inspecting of certain parts of the ship as per the mandatory periodical requirements, particularly during the dry-docking, alongside either Government or classification society surveyors.

At the college, during the next six months, stress was given to the following practical training:

- a. Metal fabrication and welding for at least one month. The cadet was exposed to different metal joining processes such as the oxy-acetylene, arc and inert gas-shield types of welding.
- b. Machining procedures in the machine shop where the cadet practised the use of common machine tools such as the lathe, milling, boring, grinding and shaping machines. One month was allocated for this.
- c. Boiler inspection both externally and internally. The cadet was given this opportunity at the boiler shop. He was made aware of the purpose of each part of the boiler mounting and how such a part helps the operator in the safe operation of the boiler. This was the best time for the cadet to learn the possible boiler repairs which he might be

- required to carry out at sea by himself.
- d. Electrical power generation using the diesel engines as applied on board ships. This period was used to help the cadet understand the system and operation. He was involved in overhaul and assembly of the diesel engine and grasped the process of fuel and air valve timing. He was made aware of the right procedure for first starting of the engine after overhaul and the necessary tests to confirm whether the assembly had been performed satisfactorily. The cadet was also to confirm that he knew the systematic way of loading the generator as well paralleling it to others on a common bus bar. This, however, depended on whether the college the cadet was attending had the facility or not. Where the equipment was not available, a detailed theory of the right procedure was given a great emphasis in order to make the cadet understand.
- e. Automation and control systems as applied to shipboard machinery. The cadet was given some practical exposure to various automatic control model systems. The most common media systems used - pneumatic, hydraulic and the electronic or their combinations were made familiar to the cadet. The ideal situation of learning was for the cadet to understand the line or circuit diagrams of the system so that he could be able to diagnose a fault in the system.
- f. Overhaul of electrical motors and alternators in the electrical workshop. Some time was allowed in the electrical workshop of the college, where

the cadets took part in the overhauling, cleaning, undercutting of commutators, smoothing of the slip-rings, dressing the carbon brushes, drying the windings from vapour and insulation improvement by varnish application and baking. Methods of insulation resistance measurement were learnt.

- g. Ship's hull design in the field of naval architecture. The cadet was involved in design of sections such as the funnel or the bulbous-nose with emphasis laid on the need for laminar flow.

Most of the theory covered during this period was intended to assist the cadet to understand better the practical aspects mentioned above and to reinforce the correspondence course material of phase II. All in all the final examinations in the theory went towards endorsements of the Ordinary National Diploma and exempted the cadet from sitting the parts A of both the 2nd and 1st class examinations for marine engineers.

### 3.2 F.G. Marine Engineers Training In Kenya

#### 3.2.1 Phase I

The 2nd group of foreign going marine engineers in Kenya did its phase I and II of training locally. The author was in the inaugural group which was recruited in early 1967. The intention was to send six cadets to the United Kingdom for the same training described above. But there arose accommodation problems. Only four of the recruited cadets could be accommodated. The other two including the author were to await for some time before a decision could be made about their alternative training. For the time

being they were sent to Mombasa's Dockyard to familiarize themselves with ship repairs. They did this for four months and in January 1968 they started on a three year sandwich course leading to the City and Guilds diploma in mechanical and electrical engineering.

The sandwich course was conducted at the Kenya Polytechnic Nairobi for all its academic work. The workshop training and experience was gained at the Kenya Railways chief mechanical engineer's workshop complex in Nairobi, Mombasa's Dockyard and the Kisumu marine workshops alternately. It was organized in such a manner that during each year there were two three month long, full-time study terms, and one part-time term per year.

During the full-time term, there were six hours of study each day, for a five day week. In the part-time study term, there were two days per week spent in the college and two hours of evening classes on each of the remaining three days. Before attending the evening classes the cadets were to have worked either at the Kenya Railways chief mechanical engineer's workshop complex or at the Railways diesel shed Makandara in Nairobi from 7 a.m. to 3 p.m. with only one hour in between for lunch.

Most of the subjects covered in the academic work were the same as the ones discussed for the training of the cadets in the United Kingdom. In fact the course validation had been conducted by the Department of Trade & Industry of the United Kingdom before allowing the marine engineering cadets to join. It had to be equivalent in material content to the courses run in the United Kingdom for the phase I training in the marine & technical colleges. The proof of the equivalence was confirmed later at the mid-

course and end of the course examinations which were set and marked at the United Kingdom for both U.K. based and Kenya based candidates. The examining body was the City & Guilds of London. Also the majority of the lecturers at the Kenya Polytechnic by then were British technical teachers who had come to assist in technical & general education under various programmes.

During the six weeks of the August holidays the cadets were divided into two groups. One group would go to Mombasa's Dockyard for workshop training while the other group went to Kisumu's marine workshops where they had the option of either sailing on the lake vessels such as the M.V. Victoria, a 1200 passenger ship, M.V. Uhuru and M.V. Umoja which are wagon ferries of 1200 GRT each, or working with the maintenance staff in the workshop or at Kisumu's drydock. The lake voyages were generally short, the longest round trip on the Victoria taking only three and a half days. These were voyages starting during the afternoons from Kisumu in Kenya, getting to Musoma in Tanzania at sunset or early evening. After dropping some passengers, she would pick others for Mwanza (Tanzania) and call into the latter port in the morning. After spending two to three hours in port the vessel would sail for Bukoba in North West Tanzania getting there in the late afternoon. The vessel would sail again after a few hours and get to Port Bell early in the morning of the second day. They would spend about five hours in this Ugandan port and start again in the evening for the return voyage. The wagon ferry voyages were generally one day long.

The advantage in these short voyages was that they allowed cadets to experience the maneuverings of the engines for

each of the three vessels. It was also possible to transfer from one vessel to the other after one or two voyages or to spend half the vocational training time on the vessels and the other half in the workshops /drydock.

It is worthwhile mentioning here that during the two full-time terms at the Kenya Polytechnic, some engineering workshop practice was done at the college's workshops. This included metal cutting and heat-treating processes. Electrical wiring, measurement and circuit's continuity testing were also carried out. Compared with the phase I training followed in the U.K., more practical work experience was gained in the sandwich type Kenyan based training since for the same Ordinary Diploma course material, three years were spent instead of two.

### 3.2.2 Phase II

As in the case of those who were training in the United Kingdom, it was a requirement to gain practical sea experience as an engineering cadet in a foreign going vessel whose engine capacity was 3000 kW or more. In the case of the inaugural group, the cadets joined the ships of the then Eastern African National Shipping Line Company which had four vessels. Three of the vessels had each a B&W engine of 5700 BHP for propulsive power and three smaller medium speed B&W diesel engines for electrical power generation. The heat recovery system included a donkey boiler connected to the exhaust system of the main engine. Steam produced in the system was used to heat the heavy fuel oil for the main engine, as well as for heating the accommodation spaces. In port the boiler was oil fired but at sea the exhaust gas waste heat was recovered through the boiler and the economizer to produce enough

steam for the purposes mentioned above.

The cadet record book was also used to ensure that each cadet at least got to know the fundamentals of marine engineering. The chief engineer and the second engineer ensured that the cadets (generally two per ship) were allocated duties with the junior engineers who showed interest in imparting knowledge to them.

Although there were no correspondence courses organized for the cadets, the chief and the second engineers kept them busy during their free time. Some of the assignments given to the cadets included tracing and making line diagrams of various systems in the ship's engine room. The fresh water system for the jacket cooling of both the main and the auxiliary diesel engines was, for example, traced and sketched. Other systems such as the fuel oil and lubrication oil for all the diesel engines were also studied. Cadets also traced the ballast and domestic water systems and sketched them. Along with these they were made to trace and sketch the boiler feed water and steam distribution as well as the fuel oil systems for the boiler. Other features to be sketched included the detail of overhauled equipment such as the lubrication and fuel oil purifiers and pumps.

The cadets were also given some time to work alongside the ship's electrician. There was a chance to do some minor services to the standby generators while at sea. Such services included cleaning of the commutators or sliprings and changing of the brushes. Insulation testing and resistance improvement for the generator and motor windings were carried out. The other challenges in electrical jobs was found on the deck machinery such as

the derricks. The electrician in consultation with the watchkeeping engineer on duty would also find suitable time to teach the cadet the procedure for starting a standby generator, synchronizing it with the running one and sharing the load between two or three generators, reducing the load from any one of them and ultimately stopping it.

From the junior engineers many things were learned by the cadets. These included recording the data of all running machinery such as the exhaust gas temperatures, the cooling water and lubrication oil temperatures and pressures. The data was either recorded in the engine room log books or interpreted immediately to cause some adjustments to be done on the running machinery to normalize the desired conditions.

From the senior engineers, the cadets learned planned and emergency maintenance of the ships' machinery. These included the overhaul of the main engine units for inspection by surveyors as per schedule and changing of spare parts where necessary. Such an operation required a co-ordinated planning between the chief engineer and the captain. The engineers themselves had to plan their work meticulously in order to save time. Each of the members of the engineering staff had a part to play. After assembly of the inspected and the renewed parts, the cadets would learn from the senior engineer in charge, the various clearance-settings relevant to the units in question. Upon experiencing a major task the cadets would take notes and strike the item from their cadet record book. They would also mark the date they gained their first experience.



### 3.2.3 Phase III

On completing 12 months at sea the cadets were ready to start phase III of training. This involved practical work at AMGEC Co, and some theoretical instructions at the Mombasa Polytechnic.

The practical training programme at AMGEC Co required the cadets to spend three and a half week days and a Saturday at the workshops. Then one and a half days in the week was spent at Mombasa Polytechnic. The subjects covered at the Polytechnic were only electrotechnology and naval architecture. There had been a feeling that the group training in Kenya had not been exposed properly to ship building and ship repairs during phases I and II of their training. This was because the Kenya Polytechnic where phase I training occurred was placed in Nairobi which is a non-port city. The course lecturer for naval architecture at the Mombasa Polytechnic was Mr. Ryami. He was a ship building foreman at the Kenya Ports Authority's dockyard. Through him, it was possible to conduct tours of the dockyard and other marine firms whenever details of any part of the ship required visual clarification. Electrotechnology was taught to assist some of the cadets who had not passed in the subject during the Diploma examinations conducted in phase I. They were supposed to resit the papers at the end of the year.

The phase III training took a period of 12 months. The AMGEC Co, as described in Chapter II has excellent facilities for practical training of marine engineers. The dry dock which handles small and medium sized ships is

fully booked for most of the year. The cadets were therefore able to involve themselves with the normal dry - docking procedures. They also familiarized themselves with major tasks such as the removal of the propellers and shafts. They inspected various types of stern tube bearings and witnessed various repair methods applicable to various damages. Similarly it was common practice for the stern tube seals of various designs to be overhauled and renewable parts changed. The cadets learned a lot from taking part in these operations. As mentioned earlier, the AMGECo undertook major repairs of both main and auxiliary engines of all types and from all sizes of ships. This was not only from the dry-docked ships but also others calling into the Mombasa Port for normal shipping. This meant that a hard working cadet always had his hands full of interesting jobs from which he learned a new thing or two. To mention but a few of the most exciting ones, there was a time when they were involved in cutting off half of a propeller blade of a super-tanker in an attempt to reduce vibrations. The opposite blade had been lost at sea. The owners did not want the ship to go into the dry dock. The ship was therefore trimmed by the head until the propeller blade was above the water surface. They spent a number of days rigging the working platform and, using electrically driven abrasion discs, managed to remove the offending blade piece. Another experience involved smoothing of the crosshead journals of a slow speed Sulzer engine. The bearing had failed and a week was spent removing the top bearing halves, honing the journals and bedding the bearings. Another major experience involved the in header expansion of the water-tubes of a large water tube boiler for a steam turbine propelled vessel.

Other interesting experience was gained in diagnosis of electrical problems pertaining to motor and generator windings. The AMGEC Co had a very knowledgeable staff in this field. Any cadet attached to this electrical section learned a lot in the way of the proper approach to solving normal electrical problems. He also had a chance to take part in motor overhaul, winding removal, coils making, insulating, slotting, assembling, varnishing, baking and test running of the completely rewound alternators and motors.

The fabrication section of the AMGEC Co offered excellent training experience. Dealing with both pipe and plate work the cadet could follow a job's progress from the drawing office to completion on the ship. Generally the AMGEC Co's naval architect would pass the drawing of the fabrication part to the shop's foreman. The foreman would give a working copy to a senior artisan who would request templates be made at the patterns shop. The templates were generally made of wood. With the templates the senior artisan assisted by the junior artisan, trainees and labourers would fabricate the item or part of the ship's hull. The foreman would be supervising the whole progress to ensure proper interpretation of the drawing. This experience was vitally important to cadets in training.

Cadets also gained invaluable experience in the machine shop and the foundry. They were attached to each of these shops for at least a month, but were free to revisit them whenever they felt that an important job was going on. Being maintenance supportive, the two shops usually dealt with the manufacture of single items. The foundry generally produced cast iron or bronze castings of ship's spares which were unavailable in the local market or those

which are out of normal production by makers due to the advanced age of the ship. The parts so produced would be moved over to the machine shop where they would be machined to size using the appropriate machining tools. The advantage in all these shops was that a keen cadet would be allowed to operate any of the machines since they were manual and in most cases similar to the ones they had learnt to operate either at the polytechnic or on board ships during phase I and II. There was the added advantage of having to learn some working shortcuts from the professional machinists against the theoretical procedures taught by the college technologists. Among the machines available in the AMGEC's machine shop were large and small lathe machines. The large ones were capable of accommodating an 18 inches diameter shaft. There were also large and small diameter crankshaft grinding machines. The cadets were lucky to take part or observe the large diameter propeller shafts being prepared for cold metal spray repairs in way of the bearings or stern tube seal sections of the shafts. Crankshaft pin and journal undersizing using the grinding machines was not uncommon.

### 3.2.4 Contrast Between Local and U.K. training

There were advantages and disadvantages of both systems of training at different phases:

a. During phase I, it was easy for the cadets training abroad to quickly understand what they were training for. This was so because most of them attended colleges which were modelled, suitably cited and equipped for marine training. In contrast Kenyan phase I training was conducted in a college modelled and equipped for mechanical and electrical engineering training besides

being located far away from any navigable waters. To many cadets, the ship was only an object of imagination. There were few marine books if any in the Kenya Polytechnic library and only one lecturer was marine-oriented.

b. There was the obvious advantage of time for the cadets trained in the U.K. Their phase I course took them two years against three in the Kenyan training. All the other phases took equal periods of time and therefore for persons of equal performance capabilities, the U.K. trained engineer cadet appeared for his certification examinations one year earlier. It is to be borne in mind however that the Kenyan trained cadet got an extra year in workshop experience. This was manifest in the later stages of his professional career.

c: The U.K. trained cadets went through British flag ships for their phase II training. The Kenyan trained cadets went through the Eastern Africa National Shipping Line ships which were carrying the flags of Kenya, Uganda, Tanzania and Zambia respectively. The outstanding contrast however was that the U.K. trained cadets had the opportunity to cover more theory at sea through the correspondence courses. These courses made it possible for their exemption from parts A of both 2nd and 1st class D.T.I. (Department of Trade and Industry U.K.) examinations. For the Kenyan trained cadets, the lack of the correspondence courses gave them an opportunity to involve themselves more deeply in ships' daily operations and in tracing the engine room systems as earlier mentioned. They had ample time to look into main and auxiliary machinery manuals which were available from the chief engineer.

d. Whilst the U.K. trained cadets had the advantage of bigger workshop and college facilities in their phase III training, half the time available was spent in theoretical work in preparation for the endorsement examinations. On the other hand the Kenyan trained cadets spent less time (about one quarter) on the theory, and the rest on practical training. This denied them the exemptions from the parts A of the 2nd and 1st class D.T.I. examinations for engineers, but made it much easier for them to pass the parts B of these examinations which generally tested the experience gained during training of a marine engineer.

### 3.2.5 Sea-time Requirement and Certification

After phase III of training both the U.K. and Kenyan trained engineering cadets joined foreign going ships as junior engineers. This was a position of an assistant to the engineer in charge of a watch. They assisted the watch engineer in maintaining a proper watch over the running machinery. In ports, the junior engineer was left in charge of the watch. He was also assigned some work to be performed during his watchkeeping hours. Such a job generally involved parts of the main engine or the auxiliary engines. Removal of external engine parts were subdivided among all the junior engineers by the 2nd engineer to make it easier for the day-working group. The junior engineer was assisted by the engine room rating (a greaser) during the night or by both the greaser and the engineering cadets during the day time. It was also the duty of the junior engineer to ensure that the bilge water from the engine room wells was pumped out through the appropriate methods available on board. It was his duty too to check and record the tank soundings for fuel,

crank-case, cylinder lubrication oil, as well as the fresh-water. In port, he was in charge of power supply and other services required for cargo operations and domestic work. He was answerable to the duty engineer on board on any engineering query from shore or on board based staff during his hours of duty in the engine room.

The D.T.I. required the junior engineers to serve 21 months at sea for those who did not hold part A of the 2nd class certificate or were not exempted from it. Those who had part A or the exemption were required to serve 18 months officially recorded in the seaman's record book and also backed by testimonials signed by both the chief engineer and the captain of the ship. The testimonials were supposed to indicate the ability, conduct and the sobriety of the candidates. Once the junior engineer felt that he had enough sea time as prescribed by the D.T.I., he posted or personally delivered his papers to the D.T.I.'s offices for assessment. As soon as he received an okay for his sea and the workshop time (experience) he applied to join any of the British marine colleges which were running the certificate examinations preparatory courses. Alternatively, one was free to directly apply to sit for the examination without attending the preparatory course. However, the majority of the candidates known to the author preferred going through the preparatory courses for at least two months prior to sitting for the examinations.

There is no sea time requirement for sitting parts A of both the 2nd and 1st class D.T.I. examinations. It was possible therefore for the Kenyan trained engineers to sit part A of 2nd class examination during their phase I training. The papers were posted to Nairobi through the

British High Commission in Kenya. The sitting was done at the Kenya Polytechnic under the invigilation of an officer from the British High Commission. The papers were then posted back to U.K. for marking by the D.T.I. Part A of the 1st class as well as parts B of the 2nd and 1st class, were sat for in the United Kingdom. To make the process cheaper one enrolled in the college for part B of 2nd class preparatory course. Upon passing the part B examination, he immediately enrolled for the 1st class part A preparatory course. After passing the two examinations he went back to sea to earn more sea time as required by the D.T.I. With part A of 1st class certificate, the sea time required was reduced to 18 from 21 months. Armed with both 2nd class motor certificate and part A of the 1st class many engineers found jobs either as 3rd or 2nd engineers on board British, Eastern Africa National Shipping Line or other foreign flag ships. They also managed to finalize the mandatory sea-time and go back to various British colleges to prepare themselves for part B of the 1st class examination. Some managed to pass their examinations on the first attempt but a few had a hard time in convincing the D.T.I. examiners as to their competence. It is worthwhile mentioning that today we have ten marine engineers with full 1st class motor certificates in Kenya. We also have eleven engineers with full 2nd class certificates. Among the eleven some have part A of the 1st class and some are only remaining to pass the engineering knowledge paper to be issued with the full 1st class certificate. Due to the reduced tempo of shipping in Kenya, like in many other parts of the world, there are no other cadets under training.



## CHAPTER IV

### REQUIREMENTS FOR TRAINING AND CERTIFICATION FOR MARINE TECHNICAL STAFF

#### 4.1 The STCW Requirements

The STCW (International Convention on Standards of Training, Certification and Watchkeeping for Seafarers, 1978), was adopted through an IMO conference held in London from 14th June to 17th July 1978. This was established as an attempt to achieve acceptable global minimum professional standards in the maritime field. Countries are expected to meet the minimum standards, but are free to exceed them.

The requirements of the S.T.C.W. Convention with regard to the engineering department in the ship are contained in Annex Chapter III of the Convention. In Regulation III/1 (4) (a) the chief engineer officer is given the duty of ensuring that watchkeeping arrangements in the engine room are adequate to maintain a safe watch. The chief engineer officer is also expected to work in consultation with the master in performing his duties. Any other engineer officer in charge of a watch is expected to work under the direction of the chief engineer officer and act as his representative at all times in ensuring safe and efficient operation and up-keep of machinery affecting the safety of the ship. Further details regarding the selection of watch keepers and their duties in maintaining a safe watch are given in Reg. III/1.

#### 4.1.1 The STCW Requirements For Chief and Second

**Regulation III/2** lays down the mandatory minimum requirements for the certification of chief engineer officers and the 2nd engineer officers of ships whose power capacity for main propulsion machinery is 3000 kW and above. The academic subjects required to be covered for both certificates are the same. The level or the depth of study on the subjects may also be the same, but the experience required for the chief engineer officer is greater. Both are required to have met the following conditions for the certification as per STCW Reg. III/2-2 quoted below:

- " (a) satisfy the Administration as to medical fitness, including eyesight and hearing;
- (b) meet the requirements for certification as an engineer officer in charge of a watch; and
  - (i) for certification as second engineer officer, have not less than 12 months approved sea-going service as an assistant engineer officer or engineer officer;
  - (ii) for certification as chief engineer officer, have not less than 36 months approved sea-going service of which not less than 12 months, shall be served as an engineer officer in a position of responsibility while qualified to serve as a second engineer officer;
- (c) have attended an approved practical fire-fighting course;
- (d) have passed appropriate examination to the satisfaction of the Administration. Such examination shall include the material set

out in the Appendix to this Regulation, except that the Administration may vary these examination requirements for officers of ships with limited propulsion power that are engaged in near-coastal voyages, as it considers necessary, bearing in mind the effect on the safety of all ships which may be operating in the same waters."

The STCW Reg. III/2-4, further adds:

"The level of knowledge required under the different paragraphs of the Appendix may be varied according to whether the certificate is being issued at chief engineer officer or second engineer officer level."

It will also be necessary to quote the syllabus guidance given by the STCW as the minimum requirements for the engineering officers mentioned above. These appear in Appendix to Regulation III/2 hereby quoted in full:

"1. The syllabus given below is compiled for examination of candidates for certification as chief engineer officer or second engineer officer of ships powered by main machinery of 3000 kW propulsion power or more. Bearing in mind that a second engineer officer shall be in a position to assume the responsibilities of a chief engineer officer at any time, examination in these subjects shall be designed to test the candidate's ability to assimilate all available information that affects the safe operation of the ship's machinery.

2. With respect to paragraph 4 (a) below, the Administration may omit knowledge requirements for types of propulsion machinery other than those machinery

installations for which the certificate to be awarded shall be valid. A certificate awarded on such a basis shall not be valid for any category of machinery installation which has been omitted until the engineer officer proves to be competent in these items to the satisfaction of the Administration. Any such limitation shall be stated in the certificate.

3. Every candidate shall possess theoretical knowledge in the following subjects:

- (a) thermodynamics and heat transmission;
- (b) mechanics and hydromechanics;
- (c) operational principles of ship's power installations (diesel, steam and gas turbine) and refrigeration;
- (d) physical and chemical properties of fuels and lubricants;
- (e) technology of materials;
- (f) chemistry and physics of fire extinguishing agents;
- (g) marine electrotechnology, electronics, and electrical equipment;
- (h) fundamentals of automation, instrumentation and control systems;
- (i) naval architecture and ship construction, including damage control

4. Every candidate shall possess adequate practical knowledge in at least the following subjects:

- (a) operation and maintenance of:
  - (i) marine diesel engines;
  - (ii) marine steam propulsion plant;
  - (iii) marine gas turbines;
- (b) operation and maintenance of auxiliary

- machinery, including pumping and piping systems, auxiliary boiler plant and steering gear systems;
- (c) operation, testing and maintenance of electrical and control equipment;
  - (d) operation and maintenance of cargo handling equipment and deck machinery;
  - (e) detection of machinery malfunction, location of faults and action to prevent damage;
  - (f) organization of safe maintenance and repair procedures;
  - (g) methods of and aids for fire prevention, detection and extinction;
  - (h) methods and aids to prevent pollution of the marine environment;
  - (i) effects of marine pollution on the environment;
  - (k) first aid related to injuries which might be expected in machinery spaces and use of first aid equipment;
  - (l) functions and use of life-saving appliances;
  - (m) methods of damage control;
  - (n) safe working practices.

5. Every candidate shall possess a knowledge of international agreements and conventions as they affect the specific obligations and responsibilities of the engine department, particularly those concerning safety and the protection of the marine environment. The extent of knowledge of national maritime legislation is left to the discretion of the Administration but shall include national arrangements for implementing international agreements and conventions.

6. Every candidate shall possess a knowledge of personnel management, organization and training aboard ships."

Similar requirements for certification of chief engineer officers and second engineer officers of ships powered by main propulsion machinery between 750 kW and 3000 kW propulsion power are given in Regulation III/3 of the STCW Convention. The minimum knowledge required for the two levels of engineering officers is similarly laid down in the Appendix to Regulation III/3.

Most of the requirements for knowledge and experience for the engineers at the two different certificates are similar except for their depth. For instance, the sea-going service for the chief engineer officers with the higher certificate is 36 months against 24 months for the lower (second engineer's) certificate. It is worthy noting that the criteria for determining the type of certificate required is the ship's main engine (propulsive) power rather than the tonnage of the ship as is the case with deck officers' certificates.

Regulation III/3 (5), empowers an engineer officer who has qualified as a second engineer officer in a ship powered by a main engine whose propulsive power capacity is 3000 kW or more, to serve as a chief engineer officer in ships of engine capacity up to 3000 kW provided he has had sea-going experience of not less than 12 months served in a position of responsibility.

#### 4.1.2 Engineer Officer in Charge of a Watch

Regulation III/4 of STCW Convention lays down the "mandatory minimum requirements for the certification of engineer officers in charge of a watch in a traditionally manned engine room or designated duty engineer officers in a periodically unmanned engine room." The Regulation is quoted below in full:

"1. Every engineer officer in charge of a watch in a traditionally manned engine room or designated duty engineer officer in a periodically unmanned engine room on a sea-going ship powered by main propulsion machinery of 750 kW propulsion power or more shall hold an appropriate certificate.

2. Every candidate for certification shall:
  - a. be not less than 18 years of age;
  - b. satisfy the Administration as to medical fitness including eyesight and hearing;
  - c. have not less than a total of three years approved education or training, relevant to the duties of a marine engineer officer;
  - d. have completed an adequate period of sea-going service which may have been included within the period of three years stated in sub-paragraph (c);
  - e. satisfy the Administration that he has the theoretical and practical knowledge of the operation and maintenance of marine machinery appropriate to the duties of an engineer officer;
  - f. have attended an approved practical fire-

- fighting course;
- g. have knowledge of safe working practices.

The Administration may vary the requirement of sub-paragraph (c) and (d) for engineer officers of ships powered by main propulsion machinery of less than 3000 kW propulsion power engaged on near- coastal voyages, bearing in mind the effect on the safety of all ships which may be operating in the same waters.

3. Every candidate shall have knowledge of the operation and maintenance of main and auxiliary machinery, which shall include knowledge of relevant regulatory requirements and also knowledge of at least the following specific items:

a. Watchkeeping routines

- (i) duties associated with taking over and accepting a watch;
- (ii) routine duties undertaken during a watch;
- (iii) maintenance of the machinery space log book and the significance of readings taken;
- (iv) duties associated with handing over a watch.

b. Main and Auxiliary Machinery

- (i) assisting in preparation of main machinery and preparation of auxiliary machinery for operation;
- (ii) operation of steam boilers, including combustion system;
- (iii) methods of checking water level in steam boilers and action necessary if water



level is abnormal;

- (iv) location of common faults of machinery and plant in engine and boiler rooms and action necessary to prevent damage.

**c. Pumping Systems**

- (i) routine pumping operations;
- (ii) operation of bilge, ballast and cargo systems.

**d. Generating Plant**

Preparing, starting, coupling and changing over alternators or generators.

**e. Safety and Emergency Procedures**

- (i) safety precautions to be observed during a watch and immediate actions to be taken in the event of fire or accident, with particular reference to oil systems ;
- (ii) safe isolation of electrical and other types of plant and equipment required before personnel are permitted to work on such plant and equipment.

**f. Anti-pollution procedures**

The precautions to be observed to prevent pollution of the environment by oil, cargo residue, sewage, smoke or other pollutants. The use of pollution prevention equipment, including oily water separators, sludge tank systems and sewage disposal plant.

#### **g. First Aid**

Basic first aid related to injuries which might be expected in machinery spaces.

4. Where steam boilers do not form part of a ship's machinery, the Administration may omit the knowledge requirements of paragraph 3 (c) (ii) and (iii). A certificate awarded on such a basis shall not be valid for service on ships in which steam boilers form a part of a ship's machinery until the engineer officer proves to be competent in the omitted items to the satisfaction of the Administration. Any such limitations shall be stated in the certificate.

5. The training to achieve the necessary theoretical knowledge and practical experience shall take into account relevant international regulations and recommendations."

Regulation III/5 lays down the conditions under which a certified engineer officer will remain proficient to serve the ships for the certificate held.

#### **4.1.3 Ratings Forming Part of an Engineering Watch**

Regulation III/6 contains the mandatory minimum requirements for ratings of an engineering watch. Since my thesis wishes to review the training requirements for all marine technical staff, the regulation is also quoted in full for clarity:

" **Mandatory Minimum Requirements for Ratings Forming Part of an Engine Room Watch:**

1. The minimum requirements for a rating forming part of an engine room watch shall be set out in paragraph 2.

These requirements are not for:

- a. a rating nominated as the assistant to the engineer in charge of the watch;
- b. a rating who is under training;
- c. a rating whose duties while on watch are of unskilled nature.

2. Every rating forming part of an engine room watch shall:

- a. be not less than 16 years of age;
- b. satisfy the Administration as to medical fitness, including eyesight and hearing;
- c. satisfy the Administration as to:
  - (i) experience or training regarding fire-fighting, basic first aid, personal survival techniques, health hazards, and personal safety;
  - (ii) ability to understand orders, and to make himself understood in matters relevant to his duties ;
- d. satisfy the Administration that he has:
  - (i) shore experience relevant to his sea-going duties supplemented by an adequate period of sea-going service as required by the Administration; or
  - (ii) undergone special training either in pre-sea or on board ship, including an adequate period of sea-going service as required by the Administration; or
  - (iii) approved sea-going service of at least six months.

3. Every such rating shall have knowledge of:

- (a) engine room watch keeping procedures and the ability to carry out a watch routine

- appropriate to his duties;
- (b) safe working practices as related to engine room operations;
- (c) terms used in machinery spaces and names of machinery and equipment relative to his duties.
- (d) basic environmental protection procedures.

4. Every rating required to keep a boiler watch shall have knowledge of the safe operation of boilers, and shall have the ability to maintain the correct water levels and steam pressures.

5. Every rating forming part of an engine room watch shall be familiar with his watchkeeping duties in the machinery spaces on the ship on which he is to serve. In particular, with respect to that ship the rating shall have :

- a. knowledge of the use of appropriate internal communication systems;
- b. knowledge of escape routes from machinery spaces;
- c. knowledge of engine room alarm systems and ability to distinguish between the various alarms with special reference to fire extinguishing gas alarms;
- d. familiarity with the location and use of fire-fighting equipment in the machinery space.

6. A seafarer may be considered by the Administration to have met the requirement of this Regulation if he has served in a relevant capacity in the engine department for a period of not less than one year within the last five

years preceding the entry into force of the Convention for that Administration."

There are many other requirements for knowledge and experience which marine technical staff are supposed to have achieved. Most of these requirements can be found in either the STCW 1978, or the Document for Guidance 1985 - which is an international maritime training guide jointly prepared by the ILO and the IMO. Other details regarding the safe practice at sea are found within various IMO Resolutions adopted during the STCW Conference.

## CHAPTER V

### 5. MODERN TRAINING PROGRAMMES SATISFYING THE STCW CONVENTION REQUIREMENTS

Many developed maritime nations have long established training programmes for their marine technical staff. Some of them are well above the requirements of the STCW Convention while others require only minor adjustments to meet the minimum standards. To be able to appreciate the many different ways in which the STCW requirements can be satisfied, I wish to review training programmes from some countries which have ratified the STCW Convention. The four countries I have chosen are India, Australia, France and the Netherlands.

#### 5.1 Training Programme in India

I find India one of the most suitable examples for Kenya to emulate because of its success in establishing a merchant fleet as well as a sound maritime administration. Being a developing country like Kenya there are many common problems arising from our similar historical backgrounds. We need to look at their past, present and future training programmes and compare them with the Kenyan ones discussed in Chapter III of this paper. Most of the information concerning the training is from the lectures by Captain Gur Saran Singh, Extra Master, F.N.I. (U.K.), and a visiting professor of the World Maritime University (WNU). Captain Saran Singh is a former nautical adviser to the Government of India. Some other information is from lectures and interviews from Captain

### **5.1.1 Pre-sea Training**

Organized training for navigational cadets started in 1927 on a training ship by the name Dufferin. Then the engineering cadet training started in 1936 on the same ship. Both the navigational and engineering cadets were given the pre-sea training on this vessel which also accommodated them for three years. Formation of the Merchant Navy Training Committee in 1947 was one major step towards the successful training of all marine personnel. The Committee recommended the establishment of a Merchant Navy Training Board as well as pre-sea and post-sea training facilities for both ratings and officers. In order to meet the rising manning demand they also recommended direct apprenticeship for both deck and engineering cadets.

Furthermore, in order to increase the output and to improve the quality of training for marine engineers, the DMET (Directorate of Marine Engineering Training) was established in 1949 at Calcutta and a branch in Bombay. It has a marine workshop and a power house. It runs a four year residential training course. Cadets are recruited at the age of 21 years or below but must have passed the final national examination after 12 years of academic education, with mathematics, physics and chemistry as compulsory subjects. In addition they must pass a selection examination set jointly by DMET and the training ship Rajendra - a successor of the Dufferin. The Bombay branch conducts only the first three years of training and the cadets join their counterparts in

Calcutta for the 4th year of study.

The present programme consists of four years of engineering training arranged as follows:

**a. 1st year:** 30% theory and 70% workshop practice in the college's attached workshops. The workshop practice involves the use of hand and machine tools.

**b. 2nd & 3rd years:** This consists of alternating theoretical and practical training periods of three months each. Theory is done in the college classrooms while practical training is done in some approved workshops in Calcutta's marine industry.

**c. 4th year:** Consists of advanced theoretical instructions in classrooms, workshops and laboratories, as well as in the college's power house. At the end of this year each cadet sits for Part A of the 2nd class examination.

Another training programme which found success and popularity was the conversion of mechanical and electrical engineering graduates to marine engineers, which was introduced in the late 1970s. There was a high demand for marine engineers which the DMET and the on-the-job training schemes could not meet. The salaries at sea were also quite attractive. It was then decided that graduates with Bachelor of engineering degree in either mechanical or electrical engineering, from any approved university, could be allowed to convert to marine engineering. The shipowners were allowed to recruit these graduates and the following procedure of training was recommended by the maritime administration and the merchant navy training board:



Eight to twelve months of workshop training in some approved workshops. The number of months spent on this training depended on how big or relevant the workshop was to marine oriented jobs. Also depending on the shipowner's decision, about three months were spent working in the ships which were in the port. On completion of this period of training the graduate would present his papers (the degree and the workshop testimonials) to the maritime administration for assessment after which they would issue him with part A of 2nd class foreign going certificate. The possession of the BE (Bachelor of Engineering) degree was the criteria for exemption. However, the graduates with BE degree in electrical engineering were required to sit for the marine engineering drawing paper for part A of the 2nd class certificate.

#### 5.1.2 Post-sea Training

The Lal Bahadur Shastri Nautical & Engineering College was set up in 1948 for this purpose, thanks to the work of the Merchant Navy Training Committee. The college offers certificate examination preparatory courses for both deck and engineering officers. The following courses are offered to engineering officers and trainees:

- a. Second class engineers\*part A.
- b. Second class engineers part B.
- c. First class engineers part A.
- d. First class engineers part B.
- e. Endorsement certificate for either steam or motor.

### 5.1.3 STCW Convention

To meet the requirements of the STCW Convention on training and certification of officers and ratings, the Lal Bahadur Nautical & Engineering College and the Maritime Training Institute run the following refresher courses:

- a. Survival at sea.
- b. Proficiency in survival craft.
- c. Tanker safety and pollution prevention.
- d. Radar maintenance.
- e. Radar simulator.
- f. Radar observer.

Special refresher courses are also organized for the ratings to update their knowledge on the matters of safety and in accordance with the STCW Convention Regulation III/6. The initial training of the ratings is of the GPC (General Purpose Crew type). This has been found to cope with the existing trend of reduced manning in foreign ships. But Indian ships are still operated under the separate engine room / deck system. There is no foreseeable shortage of labour. Therefore the GPC training for the ratings is intended to help them be employable by foreign flags. The training period is about six months but can be varied according to the technological demands of the industry.

## 5.2 Training in Australia

The information concerning the Australian training programme is from the lectures and papers written by Captain D.M. Waters who is the founder principal of the AMC (Australian Maritime College). Captain Waters is also a member of the Board of Governors and a visiting professor of the WMU (World Maritime University).

Captain Waters explains in his papers as well as his lectures that the Australian Maritime Training is being restructured to suit the present and future needs of the industry and those of the individual trainee and also be flexible enough to accommodate the 'fast rate of change' in technological developments of ships. In recognition of the world wide recession in the shipping industry, it responds positively to the shipowners trend for economizing ships' operations through reduced manning and efficient shipboard management. The ship builders' response to the reduced manning has been extensive automation of the engine room machinery whereby sensing and condition monitoring of the running machinery have been centralized at one point. It is now possible to operate all the essential machinery from this central station. Thus the need for the watchkeeping engineer to patrol the engine room has been eliminated.

The Australian training programme also addresses itself to the requirements of safety as expressed by the STCW Convention. There is need to train every member of the crew, officer and rating alike on matters of self as well as ships' safety. The best way to achieve this is found to be through team work and improved social relations between officers and ratings. Thus the Australian

training programme has been designed to integrate the GPC (General Purpose Crew) entrants and the officer trainees (engine and deck) entrants during their pre-sea training programme. The common programme runs as follows:

- a. Three weeks pre-sea training course leading to Administration's requirement - Certificate of Safety Training which covers fire-fighting, first aid and survival at sea among others.
- b. Sixteen weeks vocational training covering work in the deck and engine room departments.
- c. Pass a final examination covering the course undertaken.
- d. A further 20 weeks sea service, during which the trainee will undertake specified tasks and guided study courses and obtain relevant experience as a provisional integrated rating.
- e. After another 32 weeks of practical experience at sea, the ratings will be entitled to an unqualified certificate as integrated rating.

Upon successful completion of the 39 weeks training programme at the AMC the trainees who consist of prospective officers and ratings, are awarded the 'Certificate in Maritime Operations' (Integrated Rating) from the AMC. The officer trainees are then ready to specialize on either deck or engineer officer training as offered by the AMC.

#### 5.2.1 Marine Engineers Training

There are two courses offered which lead to the "unrestricted" certificate of competency; a "degree-level course which incorporates the 'knowledge' requirements for 'watchkeeper' and class I levels (together with all the skills applications for watchkeeper) within an educational

framework which also provides a thorough understanding of the industry and the environment within which it operates - together with specialist knowledge in technological or commercial aspects of the industry." This course provides the marine engineer with the status of a "professional engineer" who can aspire to senior positions ashore within the shipping industry.

"The course entrants for the final year only are holders of the Australian Maritime College Diploma in Marine Engineering. Candidates with equivalent qualifications such as a good Higher National Diploma (U.K.) in Marine Engineering and a First Class Engineer Certificate of Competency may be exempted from certain of the Diploma subjects."

The full degree course is of four academic years duration with the first three years covering the diploma course material. The final year consists of 30 weeks duration in which the following subjects are stressed on:

- i. Applied thermodynamics
- ii. Maritime economics
- iii. Management and two of the following three:
- iv. Ship design and operation
- v. Mechanics of machines or fluid mechanics
- vi. Mechanics and properties of materials.

The diploma course in marine engineering is designed "to provide the trainee marine engineer officer with a comprehensive course of education and training as a basis for future executive responsibility, both afloat and ashore."

"The course combines theoretical knowledge with technology and practical experience in a systematic programme incorporating the fundamental knowledge requirements for the Engineer Class I Certificate of Competency, together

with the technological, commercial and managerial knowledge required by an officer of a modern commercial ship."

Entry into the course requires university entrance qualifications which are "passes at Higher School Certificate level in four subjects including mathematics, an approved science subject - and preferably English." The college may accept other equivalent qualifications, and a bridging course is available for potential applicants who lack the full entry qualifications. The course plan is laid down in the table below:

Year	Phase	Description	Duration (weeks)	Location
1	I	Pre-sea safety training	3	College
	I	Workshop training	16	College
	II	Commercial Sea Service	20	Sea
2	III	Academic	33	College
		Workshop training	2	College
		Training vessel	3	Sea
3	IV	Commercial sea service	34	Sea
	V	Academic	13	College
4	VI	Advanced Workshop training	18	College
	VII	Training vessel	1	Sea
	VIII	Academic	22	College

Table 1.

The following five tables show how the curriculum for the marine engineering diploma and degree courses are arranged according to the training phases. Note that one lecture is composed of one hour of class instructions. Two hours of tutorials count as one lecture. Three hours of practical training or of assigned work also count as one lecture. 35 one-hour lectures are regarded as a unit.

#### CURRICULUM - MARINE ENGINEERING DIPLOMA AND DEGREE

Year 1 Phase I-22 weeks	Total	Lect	Pract	Tut	Exa.	TC	AC
1. Maths & statistics	6	4	-	2	1x3	6	-
2. Applied thermody.	3	1	1	1	1x3	3	-
3. Fluid mech. & n. arch.	3	1	1	1	1x3	3	-
4. Applied mech. & stress analysis	3	1	1	1	1x3	3	-
5. Elect. & electronic engineering	3	1	1	1	1x3	3	-
6. Eng. drawing	3	-	3	-	-	3	-
7. Material science	3	1	1	1	1x3	3	-
8. History & organization of shipping ind.	1	1	-	-	-	-	1
9. Maritime geography	1	1	-	-	-	-	1
Total hrs. / week	26	11	8	7		24	2

Table 2.

Notes:

- i. TC stands for the Technical College of Advanced Education. It shares its training facilities with the Australian Maritime College.

- ii. AC stands for the Australian Maritime College
- iii. Tut. stands for tutorials.
- iv. Ex. stands for examinations.
- v. The same abbreviations hold for tables 3 to 6.

#### PHASE II - Basic Workshop Training (Integrated)

This takes 16 weeks of safety and vocational training for all the new entrants who consist of rating and officer trainees.

#### CURRICULUM - MARINE ENGINEERING DIPLOMA AND DEGREE CONT.ed

Year 2 PhaseII-33weeks	Total	Lect	Pract	Tut.	Exa.	TC.	AC
1. Maths.& computing	4.5	3	-	1.5	1x3	4.5	-
2. Applied thermody.	3	1	1	1	1x3	3	-
3. Marine materials Sc.	3	1	2	-	1x2	2	-
4. Fluid mechanics	3	1	1	1	1x3	3	-
5. Appl. mech.& stress analysis	3	1	1	1	1x3	3	-
6. Marine electr. eng.	3	1	1	1	1x3	3	-
7. Marine electronics & instrumentation	3	1	2	-	1x2	-	3
8. Naval architecture	2	1	1	-	1x2	-	3
9. Principals of management & administr.	1.5	1.5	-	-	-	1	0.5
<b>Total hrs. / week</b>	<b>26</b>	<b>11.5</b>	<b>9</b>	<b>5.5</b>	<b>-</b>	<b>19.5</b>	<b>6.5</b>

Table 3.

The Phase V, VII, and the final year tables are continued on the next page.



**CURRICULUM - MARINE ENGINEERING DIPLOMA AND DEGREE CONT.ed**

<b>Year 3 Phase V-13weeks</b>	<b>Total</b>	<b>Lect.</b>	<b>Pract.</b>	<b>Tut.</b>	<b>Exa.</b>	<b>TC.</b>	<b>AC.</b>
1. Mathematics	4.5	3	-	1.5	1x3	4.5	-
2. Applied thermody.	3	1	2	-	-	-	3
3. Mech. of machines & stress analysis	3	1	2	-	1x3	-	3
4. Control engineering	3	1	2	-	1x3	-	3
5. Marine electr. eng. & electronics	3	1	2	-	1x3	-	3
6. Economics & oper. of sea transport	1.5	1.5	-	-	1x2	-	1.5
7. Maritime law	1.5	1.5	-	-	-	-	1.5
8. Project work	4.5	-	4.5	-	-	-	4.5
<b>Total hrs. / week</b>	<b>24</b>	<b>10</b>	<b>12.5</b>	<b>1.5</b>	<b>-</b>	<b>4.5</b>	<b>19.5</b>

**Table 4**

<b>Year 4 Phase VIII-22</b>	<b>Total</b>	<b>Lect.</b>	<b>Pract.</b>	<b>Tut.</b>	<b>Exa.</b>	<b>TC.</b>	<b>AC -</b>
1. Applied thermody.	3	-	2	1	1x3	-	3
2. Eng. mechanics	3	-	2	1	1x3	-	3
3. Mech. eng. design	6	3	1	2	1x3	-	6
4. Marine eng. project	6	-	6	-	-	-	6
5. Maritime law	2	2	-	-	1x3	-	2
<b>Total hrs. / week</b>	<b>20</b>	<b>5</b>	<b>11</b>	<b>4</b>	<b>-</b>	<b>-</b>	<b>20</b>

**Table 5**

Year 5- Degree Work 30 weeks	Total	Lect.	Pract	Tut	Exa.	TC.	AC
1. Applied thermody.	3	1	1	1	1x3	-	3
2. Maritime economics.	2	1	-	1	1x3	-	2
3. Management.	2	1	-	1	-	.5	1.5
4. Ship design & oper.	3	1	1	1	1x3	-	3
5. Mech. of machines or fluid mechanics	3	1	1	1	1x3	-	3
6. Mechanics & properties of materials	3	1	1	1	1x3	-	3
Total hrs. / week	16	6	4	6	-	1.5	15.5

Table 6.

To summarize, the Australian training programme for marine engineers has been restructured to include three main aspects:

- i. One common first year with all officer trainees and rating entrants training together on matters related to safety and pre-sea basic skills and knowledge.
- ii. Two years to cover the normal diploma course in marine engineering essential for the operational knowledge requirements for marine engineers up to class I certificate of competency.
- iii. One final year of advanced studies to accommodate the depth of degree academic level.

As shown on table 1 pp. 63, there are two major breaks from the shore training to undergo the sea training on commercial vessels. This aspect of training is bound to present some difficulties in the following ways:

- i. Obtaining enough berths in the commercial vessels for all the trainees in the same academic year.
- ii. Ensuring that all the trainees are exposed to the same training (opportunity and guidance).
- iii. Ensuring that the trainees' sea training periods will commence and terminate at the same time to facilitate the harmonious continuation of the other phases of training ashore.

The other important point to take note of is the fact that the Australian Maritime Administration has entrusted the imparting of knowledge and the examination thereof to the AMC for all the required maritime certificates. The maritime administration however, ensures that the graduates are physically fit and have the appropriate sea experience before the issue of these certificates. They also deal with renewal, endorsement and cancellation of the certificates.

### 5.3 Training in France

My source on this training is from information gathered during our study tour of the French maritime training facilities (Ecole Nationale de la Marine Marchande), the talk with the director of maritime education and visits to other places connected with maritime education and training, in April 1989. The other detailed information is from a paper written by Professor Gunther Zade, Vice

Rector of the WMU, entitled "France, 20 Years Experience with Education and Training of Bivalent Officers," dated 10th. Oct. 1988.

#### 5.3.1 Training of Dual Purpose 1st. Class Officers

The cadets are recruited through an entrance examination to the maritime academies (ENMM -Ecole Nationale de la Marine Marchande), after 12 years of general education which in France is referred to as "Baccalaureat C or D".

They then undergo the first year of training at the academy for 30 weeks. Each week has 33.5 working hours. During this period they follow a special syllabus of bivalent officers first level certificate. A copy of this syllabus has been shown in Annex 1 of this paper. At the end of the 30 weeks, an examination for entry to the 2nd year of college is held. The cadet is then supposed to join a merchant ship and gain one to two months practical experience before rejoining college for the 2nd year of studies.

The 2nd year lectures also extend for 30 weeks. The week is however made of 30.5 working hours. The list of subjects covered is slightly smaller than the 1st year's, but contains the same basic subjects. This obviously means that the students learn the subjects in more detail and with good continuity. The list of subjects and time allocated per week are also given in Annex 1. At the end of this period, another examination is held for entry into the 3rd year of college. The cadets again join merchant ships for a period such that by the end of this period the total sea experience gained between the 1st and the 2nd years is not less than four months. They then rejoin the

college for the 3rd year lectures. The 3rd year runs for 30 weeks also. They attend lectures and guided study for 32 hours per week. At the end of the of the year a major National level examination is held. This offers the successful cadets their Diplomas of Merchant Navy Officer. The cadets then join ships and serve as senior cadet officers for a period of ten months before being issued with certificates of competency of Dual Purpose Watch Officers - Merchant Navy. After this they can work as 4th or 3rd officers on either deck or engine room. They are required to work in this capacity for a period of ten months of which at least three months have to be spent on the least favoured department (deck or engine room).

Having completed the required sea service of ten months, the officers now come back for the 4th year of college studies. This will actually be on the 5th year since the beginning of training. Counting every month required it adds to five years and two months excluding any leave (holidays) taken in between.

The 4th year of college consists of 30 weeks of study for 32.5 hours per week (see the syllabus layout in Annex 1 attached). The end of this study period is marked by sitting for an examination called the Diploma of Higher Merchant Marine Studies. Then the officers rejoin the ships and work for 36 months with at least 16 months on deck and engine room each, before they can be issued with the Dual Purpose (bivalent) 1st Class Masters Certificate (unlimited). This certificate authorizes the officer to sail either as the Master or the Chief engineer of any ship size on unlimited voyages.

The examinations for the first level certificates, as all

the certificates mentioned above are referred to, consist of practicals, written and oral parts. The papers are taken in this order. Practical and written examinations contribute 28% each of the overall assessment while the oral examination contributes the remaining 44%. Candidates fail if they display an overall unsatisfactory performance, if they do not obtain any mark at all in any subject, if they fail in the International Regulations for the Prevention of Collisions at Sea or fail in maritime English.

The practical examinations are held in and organized by the academies. They may differ from each other in case the available equipment in the ENMM does not allow equal treatment of all the candidates. The examinations are conducted by the technical instructors of an academy and not by the professors.

The written examinations are organized, supervised and marked under the control of the Inspector General of the Maritime Education and Training. The examinations are held in June, the written papers nationwide on the same days at the same times for the same subjects, and the oral examinations are held on consecutive days in each academy. Those who fail in June may resit the examination on the failed paper in September of the same year.

For the written examinations each of the four marine academies proposes a set of questions for the papers in all levels of the certificates of competency to the Inspector General of MET (Maritime Education and Training) in Paris, who after careful scrutiny, selects the most appropriate questions for the next examination.

The questions for the examinations are set by the professors of an academy. Two professors are involved in the formulation of the questions on a subject basis. One professor usually sets the questions and answers and the other checks whether they are both correct. Three hundred questions and answers for the written papers are prepared each year for the students for the 1st class level certificate by each academy. Therefore a total of 1200 questions and answers are sent to the inspector of maritime education and training annually, from the four National marine academies. The preparation of an examination begins one year prior to its sitting. The chosen examination questions are printed by the Government printing press. The Inspector General of MET organizes this and provides the academies with a sufficient number of question papers.

#### **5.3.2 Other Levels of Certification**

Other than the First Class Level Certificate programme there are three others conducted through the maritime schools:

- i. The 2nd level certificate training programme which consists of 3 years of college work and 5 years of sea experience.
- ii. The 3rd level certificate training programme which covers one and half years of college work and five years of sea practical training.

#### **5.3.3 General Purpose Crew Training for Ratings**

The General Purpose Certificate for Ratings is offered as 4th level training programme. This takes three years of academic training. Each

academic year lasts 30 weeks. The scheme allocates one third of the period to general studies and the rest to vocational training. Two hours per week are however utilized on physical training. The entrants to the programme are youths of not less than 14 years of age who must be physically fit and have obtained Government recognized Swimmer's Certificate. The Certificate of Competency issued -CAPM (Certificat d'Aptitude Professionnelle Maritime de marine du Commerce), authorizes the rating to serve under both deck and engine departments as well as an electrician.

The 2nd level certificate programme is offered to bivalent officers who will sail on ships limited to 7500 G.R.T. or engines of not more than 7500 kW propulsive power.

The 3rd level certificate programme is monovalent. This is generally offered as an upgrading course to older seafarers with sea experience. The seafarers are trained in subjects related to their respective fields of experience. The final certificate offered to a deck officer under this programme is the Masters Coasting for ships of up to 1600 G.R.T. capacity. The engineering officer is offered a Chief's Coasting Certificate which authorizes him to sail on any ship whose propulsive engine power does not exceed 2250 kW.

The syllabus for the Class I bivalent training programme, and the course plans for Class I and II bivalent training programmes have been attached as Annex 1.



#### 5.4 Training in Netherlands of Semi-integrated Officers

In between the traditional training programmes of monovalent officers and the French scheme of 1967 training programme of bivalent officers, the Netherlands have as one of their training alternatives, a scheme for a semi-integrated officer. The purpose of the scheme is to produce an officer with at least the watchkeeping level of knowledge and skills in both deck and engine departments. Thus the knowledge imparted during the four years of training is diversified to cover all the fundamentals required to specialize in either deck or engine department, the first two years covering the basic subjects required to graduate in either of the two departments. This can be seen as a step towards the training of dual purpose officers in this country, after having successfully trained the General Purpose Crew (ratings). This is also to be looked at as an answer by the Maritime Education Authorities to the shipowners' cry for minimizing the operational costs through reduced manning. It can also be regarded as increasing the job opportunity for the officer so trained.

In this scheme the entrants are recruited after successfully completing their 12 years of general education and having passed well in mathematics and physics, among other subjects. The intake age is set at 18 years and above. The entrants have also to pass a physical fitness test which includes the eyesight and hearing.

The whole course programme runs over a period of four years, three of which are spent at the college and one at

sea. The sea training is done during the third year. A work-book serves as guide to the trainee as to what areas of the ship's operations and repair need more emphasis. The 4th year is used to lay ground for specialization on either nautical or engineering majors. The academic work is planned as shown below:

1st year	34	periods	per week
2nd year	34	periods	per week
3rd year	--	at sea.	
4th year	28	periods	per week

Note:(i) Each period means an instruction session of 50 minutes.

(ii) The academic year has 36 weeks.

During the 3rd year, the sea training period is divided at 50 % deck and 50 % engine room practical training. The total number of days should amount to 360 days including the sea time achieved during the first two years on the training vessel.

The course subjects coverage is as follows:

General Subjects:	Periods per Week:	
	<u>1st year</u>	<u>2nd year</u>
1. Dutch language	1	-
2. English language	1	1
3. Law	1	-
4. Business management	1	1
5. Pre- sea, first aid & health	1	1
Science Subjects:		
6. Mathematics	4	1
7. Physics, mechanics, lab. work included	6	2
8. Data processing	2	1

Vocational Subjects:	Periods per week:	
	<u>1st year</u>	<u>2nd year</u>
9. Automation techniques	3	3
10. Electric installation	2	4
11. Naval architecture	1	1
12. Radio - telephony	-	1
<b>Navigation:</b>		
13. Maneuvering		
14. Meteorology and oceanography		
15. Practice (training vessel)		
16. Navigation, instruments and systems	5	9
17. Passage planning and execution		
18. Cargo loading technology		
19. Collision rules		
<b>Marine Engineering:</b>		
20. Engineering lab.		
21. Practice (training vessel)	6	9
22. Propulsion systems		
23. Auxiliary systems		

	<u>          </u>	<u>          </u>
Total	34	34
	<u>          </u>	<u>          </u>

During these two years, two weeks per year are spent on the training vessel belonging to the Royal Educational Fund for the Navigational Industry. This time counts in the assessment for sea time requirements by the Ministry of Transport.

4th Year: Part 1:

Specialization Subjects	<u>Nautical Engineering</u>	
1. Health	1	1
2. Automation	2	2
3. Naval architecture	1	1
4. Maneuvering	1	1
5. Meteorology and oceanography	1	1
6. Practice lab., machines, and electric plants	2	2

Part 2:

7. Navigation, instruments, systems		
8. Voyage planning and execution		
9. Cargo handling technology	10	4
10. Collision rules		
11. Propulsion plants		
12. Auxiliary systems	4	10
13. Electric plants		

Examinations

Part 3:

14. Graduation paper (thesis)	3	3
15. Obligatory supplement from given optional subjects	<u>3</u>	<u>3</u>
Total	<u>28</u>	<u>28</u>

As can be seen from the list of the subjects above, the polyvalent officers cover a large number of general, technical and professional topics over the first two years of college studies. These subjects cover the basic fundamental knowledge for both deck and engine room departments. When they proceed to sea during the 3rd year of training, they are guided through the "work book" to cover both departments at 50 - 50 time allocation for

practical experience.

The difference in the specialization is characterized by time allocation only, which of course means detail and depth of the subject matter covered. This is done on the 4th year when the trainees are required to take their options on either nautical or engineering. The part one listing of subjects shows that the same topics are covered with equal time allocated to each topic for both classes. But while the topics covered during the part two happen to be the same for both classes, the time allocation signifies the bias. The nautical class is given ten periods per week for the deck oriented subjects such as voyage planning and execution, cargo handling technology, collision rules, navigation, instruments and systems. Conversely, they receive only four periods per week on engineering oriented subjects such as propulsion plants, auxiliary plants and electric plants. The order of periods' allocation is reversed for the engineering class.

It is no wonder then that an officer qualified under this programme of training will be able to carry out all the watchkeeping duties of either deck or engine room quite comfortably. When the officer qualifies with the engineering bias, the Ministry of Education, through the college, offers him a School Diploma which is equivalent to a Bsc. degree in Marine Engineering while the Maritime Administration (Ministry of Transport) offers the same graduate engineer a watchkeeper's licence (MA), as well as the deck officer's watchkeeping licence referred to as S3. It is said therefore that the semi-integrated officer trainee graduates with three diplomas. The Bsc. degree helps to stress his academic status relative to the other educational disciplines. The MA and the S3 are

professional licences or certificates of competency which are specific to the level at which the officer is qualified in ships' on board operations.

Higher licences (certificates of competency) are offered without any further examinations. But a proven sea service has to be presented to the administration together with other requirements such as the radar observer and simulator certificates. For the semi-integrated officer two years of watchkeeping experience is required. The officer who has specialized in engineering duties receives the MB licence which overrides the MA licence, while the nautical officer receives the S2 licence. After two more years of proven experience, the semi-integrated officers receive MC and S1 licences for engineering and deck respectively. These are the highest certificates of competency required to work as chief engineer and master respectively on any size ship on any trade whether foreign going or coasting.

#### 5.4.1 Older Programmes

Besides the above training programme which is the most common, two other old systems of training are in the process of being phased out. The oldest of the two is the "sandwich" system where there are no guiding educational syllabi. State examinations are however conducted by the Board of Examiners which constitutes of members of staff from the ministries of Transport and Education. This programme gives a chance to seafarers who joined the sea career directly from school at the rating level, to improve their professional status. About five certificate levels are gone through by an engineer who follows this system of certification, the last one being

the MC licence for chief engineer foreign going of unrestricted ships. The other programme which is to be phased out as well, uses the following procedure: two years initial college training separately for deck and engine room cadets (mono-valent); one year at sea working under the relevant department; 4th year of college studies again monovalent and whereby the final examinations are sat. Deck cadets graduate with S3 licences while the engineering cadets get the MA licences. Two more years of sea experience as watchkeeping officers under their relevant departments qualifies them to automatic offer of the next licence which is S2 for the deck and MB for the engineering officers respectively. After another two more years of sea experience in the record book of the officer concerned, he may come back to the college for a short updating course before he is offered the final licence which is the S1 for the master and MC for the chief engineer of foreign going ships respectively.

Another programme is on its way for a fully integrated merchant marine officer. In this programme there will be dual specialization to both deck and engineering during the whole of the four years. On passing his examinations the cadet officer will be graduating from college with a BSc. in maritime studies and a combined licence which will probably be called Maroff 3 (Marine officer third). He will then follow the sea time requirements as for the semi-integrated officers to obtain his Maroff 2 and Maroff 1 licences.

It is worthy of mention here that all ratings train under the General Purpose Crew programme.

## CHAPTER VI

### 6. LOOKING INTO THE FUTURE-TRAINING

Having reviewed Kenya's short history of appreciable marine technical training, having looked at the STCW Convention requirements and recommendations, and having cited some enviable training programmes of four countries, I now wish to draw my attention to the future training programmes for Kenya's marine engineers and their assistants in the marine technical field. These training programmes need to be tailored to meet the demands of Kenya's future shipping industry. The programmes must also address the future careers of the trainees. They must also be flexible enough to accommodate the fast rate of technological change. Finally, the programmes must meet the minimum requirements of the STCW Convention as laid down in Chapter IV.

The access to the training programmes of other countries, such as the ones described in Chapter V, places us in a very advantageous position of not having to "re-invent the wheel". Our financial capability and priority in distributing the meagre resources available may, however, lead us to taking an option which may be considered unwise by some outside observers. This should be an option suitable to the size of our shipping industry at its relatively young stage of development, and an option which is compatible with the existing lower and higher education infrastructure of our country. The option must be optimized through the use of existing facilities and expert personnel used by the well established technical (engineering) disciplines related to marine engineering.



This will help to minimize the cost. The savings can then be re-allocated to the purchase of the necessary highly specialised training equipment such as engine room simulators which can be integrated with other existing training equipment.

## **6.1 Kenya's Shipping Industry**

A short review of Kenya's maritime activities will help us to assess our training needs in terms of numbers of marine engineers, marine technicians, artisans and ratings (greasers). This will in turn guide us in selecting the most economical and satisfactory training programmes to meet the needs of the industry.

As mentioned earlier the only time Kenyan registered ships were involved actively in foreign trade was in between the late nineteen sixties and the late nineteen seventies. The early nineteen eighties saw the dwindling of the Eastern Africa National Shipping Line Company as well as the Southern Line Company. Both had represented Kenya in the international shipping arena. At the present moment, there are only two product carriers flying the national flag of Kenya, but their trade is only coastal. Plans to establish a national shipping line have been underway for the last four or five years. But the fact that the shipping demand has persistently remained lower than the merchant fleet tonnage available, has discouraged the Kenyan government and the private investors from taking bold steps towards finalising the establishment of shipping companies. It is worth noting, however, that the government's plans for establishing a national shipping company are at an advanced stage. A chairman and a caucus board of directors has already been nominated. The latest

information from reliable sources is that Kenya National Shipping Line was formally established in February 1989. A managing director, his deputy and some other managerial staff have also been appointed.

The blood stream of Kenya's shipping industry has, however, remained in the activities of the Kenya Ports Authority, which is based in the Port of Mombasa. Its container handling activities are extended to Nairobi, the Kenyan capital, through the I.C.D. (Inland Container Depot).

In spite of the worldwide recession in shipping in the nineteen seventies through the nineteen eighties, the Kenya Ports Authority's activities have been growing steadily. The tonnage handled through the port grew from three million tonnes per annum in 1963 to an average of 6.9 million tonnes per annum in the nineteen eighties. To adapt to containerization, two out of seventeen deep water berths were converted to container handling berths in 1975. In 1980, a new deep water container handling berth (No. 18) was completed and the I.C.D. came into full operation on July 1st 1984. The containers handled through the Mombasa container complex grew from 30,500 TEUs (Twenty Foot Equivalent Units) in 1980 to 119,855 TEUs in 1986.

To support the increased operations in the port, marine floating crafts have increased in numbers and have become more sophisticated. This trend is expected to continue and therefore suitable training for the marine technical staff in charge of management, operation and maintenance of these craft requires careful planning.

In addition to providing the services to the calling ships, the Kenya Ports Authority is the government's agency for the maritime administration. The Kenya Ports Authority runs the shipping office where maritime administration tasks are handled. For instance, the examinations for the home-trade certificates of competency are conducted through the shipping office. The shipping office conducts the casualty investigations as well. The Kenya Ports Authority also installs and maintains all the navigational aids in all ports as well as along the whole of the Kenyan coastline. It is expected to take over other maritime safety administration duties from the classification societies. The Kenya Ports Authority is therefore required to have enough marine engineers to be attached to the maritime administration section for various duties. These duties include surveying for both state and port control, setting and conducting examinations for all certificates of competency, and organizing and running safety and upgrading courses for junior marine engineering staff of the Kenya Ports Authority, and the country as a whole.

The other activities to be considered are the operations of the Kenya Railways Corporation craft on the Lake Victoria. Passenger services to the islands are expected to grow to meet the demands of a rising population. Cargo and passenger services to the South Nyanza ports of Homa and Kindu Bays are expected to grow to meet both population and economic growth. The trade through train wagon ferries between Kenya, Uganda and Tanzania through the lake ports is expected to grow as soon as Uganda overcomes her internal political problems. The Kenya Railways Corporation will therefore need a few well

trained marine engineers with at least the 2nd class certificate of competency to man and maintain the wagon ferry. They will also need marine engineers with 3rd class certificates of competency to run the smaller passenger and cargo vessels which provide services to the islands as well as to Homa Bay and Kindu Bay on Lake Victoria. Training for marine technicians, artisans, and ratings (greasers) for the overall requirements of the lake vessels of the Railways is to be considered.

As cited earlier, there are many fishing boats, fisheries research boats, police patrol boats and privately owned passenger boats operating in various waters of the country. Most of the engine room crew charged with the duties of running and maintaining the engine room machinery have had no formal training related to marine engineering. There is a need to establish some small institutions for training this group of workers with the aim of enhancing their efficiency and promoting safety of vessels and their crew. The training would also need to address issues such as pollution of the sea by oil and of the atmosphere by exhaust gases.

## 6.2 Training of Marine Engineers:- Recommendations

In Chapter III, I have described the various training programmes through which the present group of certificated marine engineers in Kenya have gone. Both programmes were designed by the United Kingdom to suit the British shipping industry of that time. It was particularly tailored to suit the requirements of the shipowner who was responsible for funding the education of the marine engineers from cadetship to a chief engineer's level. It was also weighted in favour of maritime safety to the

satisfaction of the maritime administration who set and conducted all the major examinations. Little consideration was given to the future careers of the then highly ranked shipboard officers. The training was long and discontinuous. The discontinuity, particularly on academic subjects, called for repetition of topics at the basic levels and therefore little time was left for in depth study of the subjects. The system was not properly integrated into the general education of the country, such that it was impossible to relate a marine engineer with a mechanical engineer for example, through the level of their training and experience.

For Kenya, I suggest that this is the most suitable moment for the Government to form a Merchant Navy Training Board. Like the Indian example given in Chapter V, the board will look into the training requirements of the shipping industry, relating it to the Country's needs and capabilities. Within the training board membership there should be qualified marine officers of both engineering and deck departments, some engineering educationists from institutions of higher learning (no lower than Government Polytechnics), and some officers from the Ministry concerned with the maritime administration.

As can be seen from my example of a training programme in India, marine engineering is closely related to both mechanical and electrical engineering. Indeed the properly trained marine engineer is well versed in these two disciplines. The subjects covered in his or her academic work embrace most of the topics covered in both the mentioned disciplines. Due to the large number of topics and the discontinuous nature of the training programmes, the depth of the topic material is curtailed.

The Indian training programme example shows that due to the close inter-relationship between the marine, mechanical and electrical engineering disciplines, it is possible to convert interested mechanical and electrical engineering graduates to marine engineers through an eight to twelve months course.

My examples of training in France and the Netherlands show training programmes which are fully integrated in the general education systems of their respective countries. In France for instance, they base their level of higher education to the number of years of training after "Baccalaureats (C or D)" in science, which is a nationally recognised level of twelve years general education. For example, a chief marine engineer's certificate of competency is equated to "Bac. + 5" while a mechanical engineer's degree is similarly equated to "Bac. + 4". The numbers 4 and 5 refer to years. In the Netherlands, the academic certificate when leaving the Marine Academy is a BSc. degree in marine engineering which is recognised by the country's body for higher education. This is the same as the Australian marine engineering programme.

It is worth noting here that even the United Kingdom has since changed their original training programmes to suit the changed needs of their shipping industry and to some extent their social expectations. The change has been difficult to implement however, due to the inertia of long standing traditions and beliefs. This lag has brought about confusion in trying to integrate the marine engineering education to the British general education system. For example, a chief marine engineer is not registerable with engineering institutes such as the Institute of Marine Engineers U.K. Deprived of this

obvious patronship, he is still highly regarded as a practising engineer at sea. This anomaly is inexplicable. The reasons given by the accrediting committees from various Institutes, that the academic depth of engineering subjects is inadequate arouse a few questions from external observers: Is it impossible to appraise the syllabus of marine engineers to the required academic depth of the subjects? Or is the recruitment level of education too low for the students to cope with the academic depth? These questions do not get satisfactory answers from either the educationists or the maritime administration. It is for these reasons that I recommend that in Kenya we should follow a slightly different path in recruiting and training our future marine engineers.

The review of our needs shows that the immediate demand for highly qualified marine engineers is not very acute. The Kenya Ports Authority, which is the boiling pot of marine activity at the moment, is adequately nourished by marine engineers from both the former Eastern Africa National Shipping Line and the Southern Line Company. Most of these engineers are in their thirties and early forties. If properly organised and motivated, these engineers may be able to man and run the Kenya Ports Authority marine engineering positions for the next ten years without panic. These positions will include those under the Maritime Safety Administration in which K.P.A. is the government's appointed agent.

The demand for marine engineers by the Kenya Railways Corporation, which is next in priority, as far as the marine activities are concerned, is not very urgent either. As said earlier there is only one wagon ferry whose propulsive twin engines are 1480 BHP (1104 KW) each.

The trade for this wagon ferry is at the moment reduced to only a few voyages per week. The workshop head at Kisumu marine workshops is presently a mechanical engineer formerly working at the Kenya Railway's chief mechanical engineer's workshops mentioned in Chapter I. He is young and capable of controlling the light marine activities with the assistance of one or two qualified marine engineers. At the moment he has one marine engineer with a second class certificate and one or two more are under training.

It is with the above background of our needs in mind, that I wish to suggest an easy path to change the training programme for our marine engineers, particularly those we wish to issue with the unlimited certificate of competency. My idea is to train marine engineers who are recognisable by the country's engineering bodies such as the Institute of Kenya Engineers. It is also my hope that the programme will make it easy for the qualifying marine engineers to get shore jobs as easily as their counterpart in other engineering disciplines as soon as they lose interest in going to sea. I feel that marine engineers should not be forced to remain at sea by reason of limited qualifications, but rather through the beneficial attractions such as the good pay, experience and adventure. My idea is to recruit for future marine engineering training, only graduate engineers whose academic level of education is the first degree. They should have a good base for post graduate specialisation in any field of engineering related to marine and mechanical engineering. They should be able to fit within the faculty of engineering in the "College of Architecture, Design and Development" of the University of Nairobi or any other equivalent university. Such a



programme will make it easy to integrate future marine engineers into the Kenya's education system of 8 - 4 - 4. The 8 - 4 - 4 system, like the French "Baccalaureats" means that a student has attended eight years of primary school education, passed a national examination, attended another four years of secondary school education and passed a national (university entrance) examination, and finally four years at university. The programmes of the degree work described below are the ones currently in force under the former education system of 7 - 4 - 2 - 3. The programmes will gradually give way to the 8 - 4 - 4 system of education in which the two years A- level course is abolished and the degree course lengthened to four years.

Both the BSc. in mechanical and electrical engineering degree programmes will be analysed as a starting base for marine engineering training. According to the 1986 -87 University of Nairobi Calender, published by the University of Nairobi, P. O. Box 30127, Enterprise Road, Nairobi, Kenya, the two probable programmes are specified as follows:

#### 6.2.1 Department of Electrical Engineering

This department offers a three years undergraduate course leading to a Bachelor of Science degree in electrical engineering. The departments of mechanical engineering, civil engineering and mathematics, and the institute of the computer science offer service courses to the department in the first and second years of study. In the final year students are able to opt for specialisation in either telecommunications or in electrical machines and power systems.

## 6.2.2 Department of Mechanical Engineering

This offers a three year course for a Bachelor of Science degree in mechanical engineering. The holders are absorbed in any of the following functions: research, development, design, fabrication, testing, selection and installation of mechanical equipment, plant and machinery as well as in many fields of industrial engineering and management.

The Bachelor of Science degree in electrical engineering offers the following courses:

### First Year

- F 110 Electrical physics.
- F 111 Electromagnetic fields and electrical measurements.
- F 112 Electrical circuit theory.
- F 114 Mechanics of fluids and thermodynamics for (E.E.).\*
- F 115 Engineering drawing for (E.E.).
- F 116 Mechanics of machines and strength of materials for (E.E.).
- F 117 Mathematics.
- F 118 Computer programming.
- F 119 Laboratory work: electrical eng. labs, basic measurements labs, civil eng. labs.

Note: (E.E.)\* stands for electrical engineering.

Part I examinations will be held in the above courses except that F 118 will be assessed by course work and continuous assessment tests only. Examinations in mechanics of fluids and thermodynamics will be a combined paper.

## Second Year

- F 210 Passive circuits and transmission lines.
- F 211 Active circuits.
- F 212 Electrodynamics and insulating materials.
- F 213 Control systems and electrical measurements II.
- F 214 Telecommunications and electrotechnology.
- F 215 Power systems and electrical machines.
- F 216 Mechanical engineering for (E.E.).
- F 217 Computer programming.
- F 218 Mathematics.
- F 219 Laboratories: Electrical eng. labs. consisting of  
electrical machines,  
telecommunications, passive circuits  
and active circuits.

Faculty examinations will be held in the above courses except F 217 which will be assessed by course work and continuous assessment tests only. There will be a fourth term after examinations.

## Third Year

- F 310 Applied electronics.
- F 311 Control engineering.
- F 312 Engineering project.
- F 313 Functions of a complex variable  
plus either
- F 314 Telecommunications.
- F 315 Microwaves and antennas  
or
- F 316 Electrical machines and electric power generations.
- F 317 Electrical power systems  
and
- F 318 Laboratories consisting of:  
(i) Control engineering.

(ii) Applied electronics.  
plus either: Telecommunications  
or Electrical power and machines

Part II University examinations will be held in all courses studied in the third year of study, except that F 312 (Engineering Project) will be examined by the presentation of a report. An honours degree shall be awarded on the basis of the aggregate marks scored in the part II of the university examinations. This is only a special award for excellence.

The Bachelor of Science degree in mechanical engineering offers the following courses:

**First Year**

F 120 Solid and structural mechanics.  
F 121 Mechanics of machines.  
F 122 Thermodynamics.  
F 123 Materials and production engineering.  
F 124 Engineering drawing.  
F 125 Mechanics of fluids (half course).  
F 126 Electrical engineering.  
F 106 Mathematics I.

Part I examinations will be held in all the above courses. In F 124, part of the final mark will be derived from practical assignments given and assessed during the year. There will be a fourth term after examinations.

**Second Year**

F 220 Solid and structural mechanics.  
F 221 Mechanics of machines.  
F 222 Thermodynamics.  
F 223 Fluid mechanics.

- F 224 Production technology.
- F 225 Materials science (half course).
- F 226 Engineering design.
- F 227 Electrical engineering (half course).
- F 207 Computer programming (half course).
- F 208 Mathematics II.
- F 229 Management for engineers.

Faculty examinations will be held in all the above courses except F 226 and F 207 will be assessed by course work and continuous assessment tests.

### Third Year

- F 320 Solid mechanics.
- F 321 Mechanics of machines and automatic control.
- F 322 Thermodynamics.
- F 323 Fluid mechanics.
- F 324 Factory management.
- F 325 Design exercise or engineering project.

In the final curriculum of any candidate who wishes to be considered for Honours shall in addition to the above requirements contain two of the following courses:

- \*F 326 Elasticity and plasticity. .
- \*F 327 Experimental stress analysis.
- \*F 328 Mechanical vibrations.
- \*F 329 Air conditioning and refrigeration.
- \*F 32C Power plants.
- \*F 32E Non-Newtonian fluid mechanics.
- \*F 32F Theory of production processes
- \*F 307 Operations research.
- \*F 32G Materials science.
- \*F 32D Advanced fluid mechanics.
- \*F 32H Fracture of materials.

\*F 32J Machine tool engineering.

\*F 30E Numerical analysis.

\*F 30D Computer programming.

Any other approved course.

\* Not all these courses will be available in any one year.  
Part II University examinations will be held in all courses studied in the third year except that F 30D will be assessed by course work and continuous assessment tests. In the case of F 326 the design drawings and a report, and the engineering project will be examined by the presentation of a report.

### 6.2.3 Contrast

Noting what I said earlier about the BSc. mechanical engineering degree programme appearing to be more relevant to marine engineering than the BSc. electrical engineering degree programme, I have a few observations to make in this regard:

- i. The modern ship's equipment is becoming more electrical oriented due to the automation and remote control systems which in most cases use electronic devices and circuits; the older generation ships' equipment was by and large mechanical and their operations were through mechanical leverage.
- ii. Due to the reduced manning of the modern ships, which is expected to be the future trend, an electrician or an electrical engineer for purely electrical duties alone is no longer a requirement as per the STCW 1978 Convention; the marine engineer has to be competent in both electrical and mechanical problem diagnosis and solution.
- iii. The condition monitoring systems (largely of

electronic design) for the modern ships' diesel engines, are nowadays very reliable; the engines are optimised for long periods of operation between overhauls; the overhauls are carried out under a planned maintenance programme by shore based staff; therefore, most of the ship's problems facing the modern engineer while the ship is under way, are almost always of an electrical nature.

My conclusion on the above matter is that the modern tendencies often form the future trend. My observation, based on the above argument, is that a degree in electrical engineering will form a better base for a future marine engineer than a mechanical engineering degree. I have however, illustrated both programmes. Some educationists in various countries still believe the mechanical engineering degree is the better bet. Their argument for the latter is that particularly in the advanced studies of marine engineering, where ship's engine and power plant design, research and development are perpetuated, then the principles mostly applicable are classified under mechanical engineering. Although this is a very sound argument, my point of view is that the majority of marine engineers we require for the Kenyan shipping industry may never be called to design and research work on the ship's machinery, but will more often than not be summoned to solve many operational problems.

The BSc. degree in either electrical or mechanical engineering, however, only forms an academic base for a marine engineer. Most of the work covered in the university is theoretical. After being recruited by a marine oriented company the graduate engineer should be

guided by a qualified marine engineer who should ensure that he gets adequate practice with machine tools, fabrications, overhauls and assemblies (of mechanical and electrical marine machinery). He should as well be given some theoretical guidance particularly in the principles of naval architecture, and marine engineering knowledge.

Working or learning under an experienced engineer is not new in Kenya. Every graduate engineer recruited in the industry serves as an assistant engineer under the guidance of an experienced engineer, for at least one year.

With our marine engineering situation in Kenya today, I suggest that the graduate engineer with the BSc. degree in mechanical or electrical engineering from Nairobi University or its equivalent follow the training programme shown below:

- i. Attached to Mombasa's Dock Yard where one marine engineer with a 1st class certificate of competency should be nominated as his guide. The marine engineer with the assistance of the chief marine engineer should draw up a one year training programme which should include among others; three months at the AMGECO's dry docking facility, three months in the dockyard's machine shop and plateyard (fabrication shop), three months on shift work aboard the port operating tugs and two months in the office/Bandari college library, one month annual leave. During the two months in the office, he should be introduced to the syllabus of the second class certificate of competency examinations. He should be



- provided with the right text books for naval architecture, marine engineering, and management knowledge .
- ii. Attached to a deep sea going ship as a watchkeeping engineer (junior engineer) for a period of eighteen months. During this period, he should become familiar with all the operational procedures, ships systems, machinery problems analysis and solutions. He should also find time to go through the text materials and prepare himself for the second class certificate of competency examination.
  - iii. Allowed a period of three months at the Bandar college library to prepare himself for the second class certificate of competency examination. He should be assisted by the marine engineer in charge of training during this period.
  - iv. Examined in two written papers: one on general engineering knowledge and the other on motor (diesel engine) knowledge. He should answer descriptive and problem-solving questions under naval architecture. He should undergo an oral examination which will be based on all aspects of ships operations, with particular emphasis on safety, environment, and economy. On passing he should be issued with the second class motor certificate of competency which authorises him to sail as a fully certificated engineer (third and second) on ships of unlimited engine capacity.
  - v. Gain experience for a period of eighteen months on board deep sea going ships in the capacity of a full engineer in charge of watch (third or second engineer). During this time he should be

responsible for organizing and carrying out planned maintenance of specific machinery parts of the overall engine room equipment. He should assist the chief engineer in supervising the junior engine room staff. He should also assist the chief engineer on matters regarding the economical running of the engine room department. He should also find time to go through the syllabus for the first class certificate of competency examination and seek assistance from the chief engineer in this regard.

- vi. Given three months to prepare for the first class motor certificate of competency examination at the Bandari college.
- vii. Examined on the same subjects as in paragraph (iv) above, but a greater detail to portray his deeper knowledge and experience should be sought for. The oral examination should be geared towards ensuring that one can now be an overall in charge of the engine room department.

I recommend that the marine engineers should be registerable with the Institute of Kenya Engineers body as soon as they write and pass their second class certificate examinations. Their written papers can be evaluated by the country's engineer's registration board, who should be advised in this regard by a senior marine engineer member of the board. It is important that the presently certificated marine engineers should all be registered at once to enable them to guide the future marine engineers without a feud.

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Having completed the above stages of training, the marine engineer is now ready to choose his field of specialization according to his interest. He may choose

to continue sailing at sea in which case he may be promoted up to the chief engineer's position depending on available opportunities. He may also choose to work within the marine shore industry, power generating stations, and other heavy mechanical workshops. His progress in all these fields will depend upon the opportunities available, but he will be qualified enough to compete with any other experienced mechanical or electrical engineer.

The process can be summarized as shown on the next page:

# CHIEF MARINE ENGINEER'S TRAINING PROGRAMME

<u>Time</u> <u>(in Years)</u>	<u>Place of</u> <u>Training</u>	<u>Purpose</u>	<u>Certificate</u>
0.25	Bandari College	preparation	1st class
1.5	Sea	experience (2nd/3rd eng.)	testimonial
0.25	Bandari College	preparation	2nd class (registerable)
1.5	Sea	experience (junior eng.)	testimonial
1.0	Workshop (Dockyard & AMGEC)	experience	testimonial
4.0	University Studies	academic eng. base	BSc. Mech. or Elect. degree
12.0	General Education	academic base	university entrance (KCE -Sc. subjects)

### **6.3 Training of Marine Technicians - Recommendations**

The needs for training marine technicians have been highlighted earlier in this paper. Properly trained marine engineers cannot perform their work efficiently without the assistance of the marine technicians. The current training programmes in Kenya are quite satisfactory, but a few recommendations can be offered.

Generally, the training of marine technicians caters for two groups of people. The first group consists of marine artisans who have excelled in their training and have shown a great aptitude to learn technical matters. This group is generally very hard working and highly motivated. They should be encouraged to cover most of the academic subject detail on their own in order to achieve the same academic level with the second group. The second group generally consists of students recruited directly from high schools (technical or grammar) after passing their KCE (Kenya Certificate of Education) examination, given at the end of the twelve years of education. The results of the KCE examination for this group is slightly lower than the university entrance requirements.

In training the marine technicians therefore, our first aim is to impart the academic knowledge necessary to understand the reasons why certain technical procedures are followed and others discouraged. They also need to learn how to organize working groups to accomplish defined tasks in the workshops as well as in the ships' engine rooms. Thirdly, they need to be academically prepared for advanced studies in engineering. In this respect, I recommend that extra-curricular be incorporated into the diploma course to raise the academic level of the few

technicians who are motivated enough to attempt learning the degree level material. There should be an open door for technicians to become engineers and this stage should be clearly marked. My recommendation is that the syllabus for higher diploma should be reviewed and appraised where necessary to include all the subject detail requirements for the degree work. In other words, the education system should recognize technicians as those having the diploma level engineering qualification. The higher diploma level should then be abolished and instead a degree be issued. This will remove the ambiguity between the different technical (engineering) groupings in the country.

At this juncture, I recommend that it should not be possible for a marine, electrical or mechanical engineering technician to attempt the second class motor certificate of competency examination before he achieves the degree level qualification from a university or a polytechnic. He may, however, attempt all the home trade certificate of competency examinations as long as he meets the other prevailing requirements. The highest certificate on this line should be the third class motor certificate of competency.

Regarding the facility for training the marine technicians, my observations are that the Kenya Polytechnic Nairobi and the Mombasa Polytechnic are well established institutions to issue diplomas in mechanical and electrical engineering. The Mombasa Polytechnic stands a better chance of establishing a diploma in marine engineering due to its coastal location. The polytechnic is in fact located on the Tudor creek with one of the land boundaries touching the sea. However, I do not think the establishment of a marine diploma course to be of high

priority in Kenya today. A combined diploma in mechanical and electrical engineering as offered by these polytechnics is good enough for marine technicians. However, both Kenya and Mombasa Polytechnics need a lot of modernisation, particularly in terms of training equipment. For instance, modern training methods require the use of computers for information processing and storage. The computer is becoming a working tool both at home and in the industry. The use of computers in schools today is comparable to the use of the slide rule in the 1960s. It should be encouraged in every learning process especially from the high school level onwards. Our polytechnics, universities and other institutions of higher learning should consider computers as working tools for both students and the teaching staff, without which much time and effort is applied with very little output. Efforts to equip these institutions with computers should therefore not be spared.

#### **6.4 Training of Marine Artisans - Recommendations**

There is a wide group of workers to be considered. We have large groups working for Kenya Ports Authority, Kenya Railways Corporation, AMGECCO, Southern Engineering, Kenya Fisheries, Shipmark and many other small boat repair workshops.

Except for the marine artisans employed by the first four corporations and companies mentioned above, specific training programmes are difficult to organize. It is therefore recommended that each employer is informed about the government's requirement that wages for each level of artisans employed be based on the government trade test certificate held. The worker's representatives should

thus approach the employers and persuade them to devise a system of ensuring that the artisans get a chance to improve their knowledge and skills in order to progress in their earning capabilities.

Training facilities for artisans in general are numerous throughout the country. Most students get their first stage of technical training in the communally established village polytechnics. They then try to get into employment or join the "Harambee Institutes of Technology" for further training. At these institutes they train and sit for government trade tests in various trades such as motor mechanics and electrical installation. There are three levels of the government trade tests -III, II, and I. An artisan may be required to pass all the three grades of government trade test before he even gets employed. Conversely, the artisan may be employed before attempting the trade tests and pass the three grades while working. This is an advantageous alternative because it is possible for the employee to seek promotion on the strength of the trade test passed.

\*Note: "Harambee institutes of Technology " are technical colleges and schools established in Kenya by communities on self-help basis, organized mostly at the District level. These institutes cater for KCE graduates who failed to get places in government run institutes of higher learning. Technical and commercial courses are offered in these institutes. Examinations are set and certificates issued by the government in most of them.

The training discussed above is dependent on each individual's effort. The trainee generally pays for his tuition, stationery and other equipment. Most of the village polytechnics and Harambee Institutes of Technology



are poorly financed. However, these are the only training facilities open to artisans who are self employed as well as those employed by very small companies. My simple recommendation on this sector is to request the government to give more donations in the form of training equipment and technical staff to these institutions in order that they may continue doing a commendable job.

As mentioned earlier in Chapter II, the Kenya Ports Authority and the Kenya Railways Corporation and to a limited extent the AMGECO, all have defined programmes of training for their marine artisans and greasers. The state of the economy has however, affected the rate of growth of these training facilities. The above firms have a small training section (school) each, within the workshop complex, where marine artisan training is initiated. The Kenya Ports Authority for instance has a marine section within the Bandari College. The Kenya Railways Corporation has got the Railway Training School in Nairobi and a small marine training school at Kisumu. These facilities were established with the noble aim of training marine artisans and greasers. The equipment used in these centres presently has, in most cases, ceased to be used elsewhere in the world. There are no modern teaching aids such as overhead projectors, videos, large scale marine engine drawings, manuals or models. Practice materials and training gear are in short supply. Training vessels, diesel engine simulators and computers are unheard of in these training facilities. Properly trained technical staff are also inadequate in all these training schools. My recommendations to the above firms are:

- i. to note that there are many benefits which arise out of well trained marine artisans, although there is no clear way of assessing the

benefits.

- ii. there is a great need to modernize the training equipment in the training facility for the marine artisans since the artisans are required to work on modern equipment on new ships after their training.
- iii. there is a need to recruit and re-train the technical teachers.

In my final conclusion I wish to remind all my readers that training in any field is a continuous process. Training programmes need to be reviewed, evaluated and updated. As the needs change further evaluation becomes necessary. Understandably, the whole process becomes too expensive for those of us in the third world. But to give up training means that we shall never maintain our own equipment without importing the more expensive foreign expertise. There are various international aid agencies who are sympathetic to our type of training problem. A few of these agencies which can be contacted for assistance are:

- i. International Maritime Organization's technical committee.
- ii. International Labour Organization (ILO).
- iii. United Nations Development Programme (UNDP).
- iv. Swedish International Development Agency (SIDA).
- v. Norwegian Agency for Development (NORAD).
- vi. International Centre for Ocean Development (ICOD).

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# ANNEX I

## MARITIME EDUCATION AND TRAINING IN FRANCE

### Syllabus of Bivalent First Level Certificate

#### 1st Year

<u>Courses</u>	<u>No. of Hrs/Week*</u>
1. Mathematics	3.00
2. Electricity	1.50
3. Nautical astronomy	1.50
4. Navigation	4.00
5. Thermodynamics, ship's machinery	4.00
6. English language	3.00
7. Maritime law	1.00
8. Ships technology and equipment, collision avoidance, port signals	1.00
9. Workshop technology and machinery equipment	2.50
10. Technical drawing	3.00
11. Electronic data processing	2.00
<u>Laboratories</u>	
12. Electricity	1.00
13. Fuel oil, lubricating oil, boiler water	

analysis	0.50
14. Workshop and machinery equipment	1.50
15. Signals and communication equipment procedures	0.50
16. Navigation	0.50

#### **Seamanship - First Aid**

17. Rope work, life saving appliances and survival techniques	0.75
18. Life boats	1.00
19. First aid	1.00
<b>Total</b>	<b>33.25</b>

Note: Each year consists of 30 weeks;

\*Hrs/week is short form for hours per week.

Physical Education and Sports - held on Thursday  
afternoons.

#### **2nd Year**

##### **Courses**

1. Mechanics and strength of materials	3.00
2. Electricity	2.00
3. Radioelectricity, electronic	1.50

4. Fluid mechanics and ship's machinery	4.00
5. English language	3.00
6. Navigation, nautical calculation, and maritime law	0.75
7. Ship construction	0.75
8. Technical drawing, plan reading	3.00
9. Automation	1.00
10. Electronic data processing	2.00

#### Laboratories

11. Ship's machinery	1.50
12. Electricity	1.50
13. Electronics (every 3 weeks 1.5 hrs)	0.50
14. Navigation	1.00
15. Automation	<u>1.00</u>

<b>Total</b>	<b><u>30.50</u></b>
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Physical Education and Sports - held every  
Thursday afternoon

#### 2nd Year

##### Courses

1. Electricity	1.50
2. Radioelectricity, electronics	1.50
3. Ship's machinery	5.00

4. English language	3.00
5. Ship stability	0.75
6. Navigation, nautical calculation, chartwork	2.25
7. Ship handling	0.25
8. Commercial law	1.00
9. Cargo handling	0.75
10. Automation	2.00
11. Meteorology	1.00
12. Collision avoidance regulations, aids to navigation, port signals	0.50
13. Safety	1.50

#### Laboratories

14. Ship's machinery	1.00
15. Engine practice	3.00
16. Electricity	3.00
17. Electronics	1.00
18. Navigation	1.00
19. Automation	1.00
20. Conferences, workshops, shipyard and factory visits average time	1.00

**Total 32.00**

Physical Education and Sports - held every  
Thursday afternoon.

#### **4th Year**

##### **Courses**

1. Electricity	1.50
2. Radioelectricity, electronics	2.50
3. Ship's machinery	1.50
4. English language	3.00
5. Ship Stability	1.50
6. Navigation	1.25
7. Rules and regulations	1.00
8. Ship handling	0.75
9. Ship protest	1.50
10. Cargo handling	1.00
11. Collision avoidance regulations, radar simulator	1.50
12. Ship's accidents, damage repair, safety	1.50
13. Automation	2.50
14. Maritime trade	1.00
15. Claims and accountancy	1.50
16. Shipboard sanitation	0.50

##### **Laboratories**

1. Electricity	1.50
2. Electronics	3.00
3. Automation	1.50
4. Shipboard sanitation	0.50
5. Meetings, visits	2.00

**Total**

**32.50**

**Physical Education and Sports** - held every Thursday afternoon.

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